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Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

CERNAVODĂ – NPP AND THE NATIONAL NETWORK FROM THE SOUTH-EASTERN ROMANIA

ROMANIA

04 to 12 JUNE 2007

Reference: RO-07/4

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Monitoring installations for radioactive discharges at the Cernavodă nuclear power plant and for the surveillance of environmental radioactivity in the south-eastern part of Romania
SITE:	Cernavodă NPP, Romania
DATE:	04 to 12 June 2007
REFERENCE:	RO-07/4
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DATE OF REPORT:	21/11/2008

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1 ABBREVIATIONS

ALMERA	Analytical Laboratories Monitoring Environmental RAdioactivity
ANSVSA	*Autoritatea Națională Sanitară Veterinară şi pentru Siguranța Alimentelor* (National Sanitary, Veterinary and Food Safety Authority)
ASP	*Autoritatea de Sănătate Publică* (Public Health Authority)
BIPM	*Bureau International de Poids et Mesures*
CANDU	CANadian Deuterium Uranium
CNCAN	*Comisia Națională pentru Controlul Activităților Nucleare* (National Commission for Nuclear Activities Control)
CNE	*Centrala NuclearoElectrică* (NPP)
CRL	CNCAN's Reference Laboratory for radioactivity
DEL	Derived Emission Limit
DG	Directorate General
EC	European Commission
EWS	Early Warning System (environmental radiation monitoring system)
FWHM	Full Width Half Maximum (measure for detector energy resolution)
GEM	Gaseous Effluent Monitor
GM	Geiger Müller (radiation detector)
GPRS	General Packet Radio Service
HEPA	High Efficiency Particulate Air (filter)
HPGe	High Purity Germanium (gamma radiation detector)
IFIN-HH	*Institut național de cercetare-dezvoltare pentru fizică şi inginerie nucleară – Horia Hulubei* (Horia Hulubei National Institute of Research and Development in Physics and Nuclear Engineering)
INMH	*Institutul Național de Meteorologie şi Hidrologie* (National Institute of Meteorology and Hydrology)
IPH	Institute of Public Health
LEM	Liquid Effluent Monitor
LEPA	Local Environmental Protection Agency
LSC	Liquid Scintillation Counter (radiation detector)
MAAPDR	*Ministerul Agriculturii, Alimentației, Pădurilor şi Dezvoltării Rurale* (Ministry of Agriculture, Forests and County Development)
MCA	MultiChannel Analyzer
MDA	Minimum Detectable Activity
MMDD	*Ministerul Mediului şi Dezvoltarii Durabile* (Ministry of Environment and Sustainable Development)
MPH	Ministry of Public Health
NaI(Tl)	Sodium iodide, thallium activated (gamma radiation detector)
NEPA	National Environmental Protection Agency
NERSN	National Environmental Radioactivity Surveillance Network
NORM	Naturally Occurring Radioactive Material
NPP	Nuclear Power Plant
NRL	NEPA's Reference Laboratory for radioactivity
OBT	Organically Bound Tritium
ODC	Operating Document Control
OG	Official Gazette
OJ	Official Journal
QA / QC / QM	Quality Assurance / Quality Control / Quality Management
RENAR	Romanian Accreditation Association
RP	Radiation Protection
Si(Li)	SIlicon LIthium drifted (radiation detector)
SNN S.A.	*Societatea Națională Nuclearelectrica S.A.* (NPP operator)
SSRM	Survey Station for Radiological Monitoring within NERSN (radiological sector of LEPA laboratoires)
TREN	TRansport and ENergy
UPS	Uninterruptible Power Supply

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 (EC) the right of access to such facilities in order that it may verify their operation and efficiency.

For the EC, the Directorate-General for Transport and Energy (DG TREN) and in particular its Radiation Protection Unit (TREN H4) 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:

- 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 (OJ 2006/C 155/02) with a view to define some practical arrangements for the conduct of Article 35 verification visits in Member States.

From 4 to 12 June 2007 a verification team from DG TREN visited the site of the Cernavodă nuclear power plant and various environmental radioactivity monitoring and measuring sites located in the south-eastern part of Romania (Dobrogea region). The Horia Hulubei National Institute of Research and Development in Physics and Nuclear Engineering (IFIN-HH) was visited with regard to certain aspects.

The visit also included meetings with representatives of various national authorities having competence in the field of radiation protection. An opening meeting was held, with all parties involved during the visit, on the premises of the National Commission for Nuclear Activities Control(CNCAN).

The present report contains the results of the verification team's review of relevant aspects of the radiological environmental surveillance on and around the site of the Cernavodă nuclear power plant, as well as of the regional radiological surveillance in the south-eastern part of Romania. The visit of the custom's food (import) control facilities in Constanța harbour was also included in the present document.

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

3 PREPARATION AND CONDUCT OF THE VERIFICATION

3.1 PREAMBLE

The Commission's decision to request the conduct of an Article 35 verification was notified to the Romanian Permanent Representation to the European Union by letter TREN.H4 CG/cd D(2007) 301324 dated 6 February 2007.

At the preparatory meeting held in Luxembourg on 12 March 2007, a preliminary programme of verification activities under the terms of Art. 35 was discussed and agreed upon with the Romanian delegation.

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

Verification activities were conducted by two independently operating teams. One team focussed on discharges from the Cernavodă nuclear power plant (in the Dobrogea region), whereas the other one verified the site related environmental radioactivity monitoring as well as parts of the radiological monitoring within the national network (south-eastern part of Romania /Dobrogea region).

Practical arrangements for the implementation of these verifications were made with the Romanian competent authorities.

The present report covers these verifications on the site of the Cernavodă NPP and in the south-eastern part of Romania.

3.2 PROGRAMME OF THE VISIT

On 04 June 2007 an opening meeting was held at the CNCAN premises in Bucharest where, in conjunction with the Romanian competent authorities and the operator of the Cernavodă NPP, the programme of verification activities was discussed and finalized.

The agreed programme comprised:

- The verification of liquid and gaseous radioactive discharges from the Cernavodă NPP (sampling and monitoring systems, analytical methods, quality assurance and control aspects, reporting);
- The verification of the Cernavodă site-related environmental radiological monitoring programmes as implemented by the operator of the NPP and by the regulator.

  The verification addressed technical aspects of monitoring and sampling activities, analytical methods used, quality assurance and control, archiving and reporting.
- Verification activities at the CNCAN laboratory of environmental radioactivity, addressing infrastructure, analytical methods, quality assurance and control aspects, reporting. At the same time the monitoring and sampling provisions located on the laboratory premises were also subjected to verification.
- Verification of part of the national monitoring network.

An overview of the programme of verification activities is provided in Appendix 1 to this report.

The verifications were carried out in accordance with the programme.

3.3 DOCUMENTATION

In order to facilitate the work of the verification team, a package of information was supplied in advance by the Romanian authorities. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 2 to this report. The verification team notes the comprehensiveness of all presentations made and documentation provided.

The information thus provided has been extensively used for drawing up the descriptive sections of the report.

3.4 REPRESENTATIVES OF THE COMPETENT AUTHORITIES AND THE OPERATOR

During the verification visit, the following representatives of the national authorities, the operator and the other parties involved were met.

NPP Cernavodă:

Mr Ionel Bucur	Director Cernavodă NPP
Ms. Mitica Baraitaru	Laboratory supervisor, Personnel Dosimetry Laboratory
Mr Ion Popescu	Superintendent, Health Physics Technical Services,
Ms. Elena Bobric	Health Physicist Senior Engineer, responsible for Effluents and Environmental Programmes
Ms Cristina Bucur	Laboratory supervisor, Environmental Monitoring Laboratory
Mr Dina Dumitru	Senior Superintendent, SNN Nuclear Safety Surveillance Department

Mr Vasile Simionov	Station Health Physicist
Ms Ileana Simionov	Senior Technician, Environmental Monitoring Laboratory
M. Bogdan Dinu	System engineer
Mr Ştefan Murgoci	Senior Commissioning Engineer
Ms Carmen Tudor	System Engineer
Ms L. Stanciu	Supervisor, NPP Public Relations
Mr A. Nedelcu	System Engineer

National Environmental Protection Agency (NEPA), Bucharest

Ms Crina Hoţoiu	Director of National Reference Laboratory
Ms Elena Simion	Head of National Reference Radioactivity Laboratory

Local Environmental Protection Agency (LEPA), Slobozia

Mr Adrian Oprescu	Director of the Laboratory
Ms Tarsiţa Silvestru	Coordinator of SSRM Slobozia
Ms Teodora Furnică	Technician, SSRM Slobozia

Local Environmental Protection Agency (LEPA), Călăraşi

Ms Elena Adrian	Head of Monitoring, Synthesis and Co-ordination Department
Ms Simona Cristache	Coordinator of SSRM Călăraşi

Local Environmental Protection Agency (LEPA), Constanţa

Mr Adrian Manole	Executive Director
Ms Daniela Şerban	Head of the Monitoring Department
Ms Claudia Puşcaşu	Coordinator of SSRM Constanţa
Ms Maria Ţintea	Coordinator of SSRM Constanţa
Ms Daniela Dima	Physicist
Ms Irina Tavitian	Physicist

National Commission for Nuclear Activities Control (CNCAN), Bucharest

Mr. Vilmos Zsombori	President, State Secretary
Ms. Daniela Căsaru	Director of International Affairs
Ms. Mihaela Ion	Senior Expert, International Affairs Division
Ms Oana Velicu	Head of the Radiation Protection and Radioactive Materials Transport Section, Division of Radiation Protection and Radioactive Waste
Ms Adriana Baciu	Acting Head of the Section for Radiation Emergencies
Mr Paul Stoica	Expert, Section for Radiation Emergencies
Mr Florin Lolea	Expert, Section for Radiation Emergencies

National Institute of Physics and Nuclear Engineering "Horia Hulubei" (IFIN-HH), Măgurele

Mr Nicolae Victor Zamfir	General Director, Member of the Romanian Academy
Mr Mitică Drăguşin	Nuclear Safety Director
Mr Constantin Ivan	Technical Director
Ms Ana Stoichioiu	Head of Monitoring, Environmental Radioactivity Laboratory of Life and Environmental Physics Department
Mr Viorel Fugaru	Radiation Protection Responsible, Research and Radioisotopes Production Department
Mr Florin Buzatu	Scientific Director
Ms Felicia Dragolici	Head of the Radioactive Waste Management Department
Ms Cătălina Cîmpeanu	Head of the Research and Radioisotopes Production Department

Mr Ioan Rapan	Engineer, Maintenance Services, Research and Radioisotopes Production Department
Mr Aurelian Luca	Scientist, Gamma Spectrometry Laboratory, Research and Radioisotopes Production Department
Mr Romeo Mărgineanu	Head of Gamma Spectrometry Laboratory, Environment, Life and Environmental Physics Department
Mr Ion Tudor	Specialist, Environment, Life and Environmental Physics Department

Institute of Public Health (IPH), Bucharest

Mr Constantin Milu	Physicist, Head of the Radiation Hygiene Laboratory
Ms Raluca Gheorghe	Physicist, Institute of Public Health Bucharest

Public Health Authority (ASP), Constanţa

Mr Marius Dumitru Enescu	Executive Director of the Authority of Public Health of Constanţa County
Ms Mihaela Dinisov	Deputy Executive Director
Ms Mirela Calboreanu	Head, Radiation Hygiene Laboratory
Ms Elena Curuia	Physicist, Radiation Hygiene Laboratory
Ms Doina Paula Balaban	Chemist, Radiation Hygiene Laboratory

National Sanitary, Veterinary and Food Safety Authority, Bucharest

Ms Maria Magdalena Andresescu	Director, Directorate for Control and Co-ordination of Veterinary Pharmaceutical Activities

National Institute for Marine Research and Development "Grigore Antipa", Constanţa

Mr Vasile Pătraşcu	Physicist Engineer

4 ENVIRONMENTAL MONITORING LEGISLATION

4.1 LEGAL PROVISIONS FOR NPP DISCHARGE AND ENVIRONMENTAL RADIOACTIVITY MONITORING

The discharge and monitoring of radioactive effluents resulting from the operation of a nuclear installation is regulated by CNCAN in accordance with the provisions of:

- **Law 111/1996 on the safe deployment, regulation, authorization and control of nuclear activities, republished**

and

- **Fundamental Norms for Radiological Safety, approved by CNCAN President Order No. 14/2000**

as well as the specific provisions of:

- **Norms regarding the limitation of the radioactive effluents discharges to the environment, approved by CNCAN, President Order No. 221/2005;**
- **Norms regarding the monitoring of radioactive emissions from nuclear or radiological facilities, approved by CNCAN, President Order No.276/2005;**
- **Norms regarding the monitoring of environmental radioactivity around nuclear and radiological facilities, approved by CNCAN, President Order No.275/2005.**

These norms set up the following:

- Requirements concerning the assurance of radiological safety of occupational exposed workers, population and environment, in accordance with the provisions of Law no. 111/1996 and in accordance with the 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.

- Requirements for the calculation of the Derived Emission Limits (DEL) and for the monitoring of radioactive discharges, at the source of emission and in the receiving media, in routine conditions and also in emergency situations. It also includes specific requirements for the monitoring of radioactive emissions and for the environmental radioactivity monitoring activities of a CANDU-type reactor.

4.2 LEGAL PROVISIONS FOR NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING

4.2.1 Environment

Legislative acts establishing the responsibilities in the field of environmental monitoring of radioactivity in sensu strictu are:

- The Environmental Protection Decree no. 195/2005;
- Ministerial Order 338/2002, Rules for National Environmental Radioactivity Surveillance Network ;
- Law no. 265/2006 for approving the Government Emergency Ordinance no. 195/2005, regarding the environmental protection;
- Governmental Ordinance 21/2004 regarding the National System for the Management of Emergencies;

4.2.2 Foodstuffs

Legislative acts establishing the responsibilities in the field of radioactivity in foodstuffs and feeding stuffs are:

- Regulation 178/2002 – laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety;
- Ministerial Order no. 570/2007 of the Ministry of Public Health (MPH), regarding the technical norms for implementing, evaluation and financing of national programmes, (Programme 1, national programme of prophylaxis, sub programme of public health, objective 4, preventing diseases related to environmental and occupational risk factors, published in the OG, 2007);
- Order no. 381/15.04.2004 of the MPH approving the "Sanitary norms for safe deployment of nuclear activities", published in the Romanian Official Bulletin no. 527/11.06, 2004;
- Order no. 1050/97/1145/505 of the Ministry of Agriculture, Forests and County Development (MAAPDR), National Sanitary, Veterinary and Food safety Authority (ANSVSA), MPH, National Environmental Protection Agency (NEPA) for the approval of the sanitary, veterinary and food safety Norms regarding certain contaminants from food of animal and non-animal origin, published in the OG no. 1056/26.11, 2005;
- Order no. 855/98/90/2002 of the MPH, MAAPDR, NEPA for the approval of the norms regarding foods and food ingredients treated with ionizing radiation, published in the OG no. 218/25.04, 2002;
- Order no. 1805/286/314/2006 of the MPH, ANSVA, CNCAN for the approval of instructions regarding the creation of a legal framework for the application of the Council

and European Commission Regulations regarding the establishment of maximum levels for radioactive contamination for food and feeding stuffs, after a nuclear accident or in a radiological emergency, for special conditions for the export of food and feeding stuffs, following a nuclear accident or other radiological emergencies as well as conditions governing imports of agricultural products from other countries following the Chernobyl nuclear power-station accident, published in the OG no. 41/19.01, 2007;

- Related European Community legislative acts[2].

4.3 GUIDANCE DOCUMENTS

The environmental radioactivity monitoring and the radiological surveillance of foodstuffs follow international guidance documents from EU, IAEA and Canada[3]. ICRP's recommendations are applied as well.

2

- Commission Regulation (EC) No 1609/2000 of 24 July 2000 establishing a list of products excluded from the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. (OJ L-185, 25.7.2000, page 27);
- Commission Regulation (EC) No. 1661/1999 of 27 July 1999 laying down detailed rules for the application of Council Regulation (EEC) No. 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. (OJ L 197, 29.7.1999, p. 17–24);
- Commission Regulation (EURATOM) No. 770/90 of 29 March 1990 laying down maximum permitted levels of radioactive contamination of feedingstuffs following a nuclear accident or any other case of radiological emergency. (OJ L 83, 30.3.1990, p. 78–79);
- Commission Regulation (EURATOM) No. 944/89 of 12 April 1989 laying down maximum permitted levels of radioactive contaminants in minor foodstuffs following a nuclear accident or any other case of radiological emergency. (OJ L 101, 13.4.1989, p. 17–18);
- Directive 1999/2/EC of the European Parliament and of the Council of 22 February 1999 on the approximation of the laws of the Member States concerning foods and food ingredients treated with ionising radiation. (OJ L 66, 13.3.1999, p. 16–23);
- Directive 1999/3/EC of the European Parliament and of the Council of 22 February 1999 on the establishment of a Community list of foods and food ingredients treated with ionising radiation. (OJ L 66, 13.3.1999, p. 24–25);

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- 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;
- IAEA Safety Guide No. RS-G-1.8 “Environmental and Source Monitoring for Purposes of Radiation Protection” (2005);
- IAEA Safety Guide no. WS-G-2.3 “Regulatory Control of Radioactive Discharges to the Environment” (2000);
- Canadian Standard CAN/CSA-N288.4-M90-Guidelines for Radiological Monitoring of the Environment (1990);
- 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 population as a whole (2000/473/Euratom);
- Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption (transposed by Law no. 458/2002 for the quality of drinking water as modified by Law no. 311/2004, published in the Romanian Official Bulletin no. 582/2004);
- Commission recommendation of 20 December 2001 on the protection of the public against exposure to radon in drinking water supplies (2001/928/Euratom);
- Guidelines for drinking water quality (WHO Recommendations), Chapter 9 - Radiological aspects;
- Measurement of radionuclides in food and environment (IAEA Guidebook – Technical reports series no. 295);

5 ROMANIAN COMPETENT AUTHORITIES

5.1 INTRODUCTION

According to the legislative framework in Romania, CNCAN is the only authority having responsibility with regard to radioactive discharges.

The main ministries and organizations having different responsibilities in the field of environmental radioactivity monitoring (including the surveillance of foodstuffs) are:

- CNCAN;
- Ministry of Environment and Sustainable Development (MMDD), through NEPA;
- Ministry of Public Health (MHP), through the public health authorities and the network of ionizing radiation hygiene laboratories;
- Ministry of Agriculture, Forests and County Development;
- National Sanitary Veterinary and Food Safety Authority (ANSVSA).

Additionally, there is another governmental body, the Nuclear Agency, a specialised body of the central public administration, under the control of the Ministry of Economy and Finance. The agency provides technical assistance to the Government, by elaborating strategies for national programs in the nuclear domain. It draws up and monitors the implementation of research, development and innovation policy in the nuclear field.

The agency can ask CNCAN to supply information regarding the safety of nuclear installations in order to issue their own report. The elaboration of the national nuclear safety strategy is the task of CNCAN. However, the agency can update its own national strategy on nuclear field development, using CNCAN's data.

5.2 NATIONAL COMMISSION FOR NUCLEAR ACTIVITIES CONTROL (CNCAN)

The National Commission for Nuclear Activities Control (CNCAN) is a national public institution, acting as a legal entity. It is the national competent authority in the nuclear field and functions under the direct responsibility of the Prime Minister.

Since its creation in 1961 CNCAN faced various reorganisations.

The first regulatory organisation in the field of nuclear practices occurred in 1961, imposed by *Ministerial Order 741/1961*. The body was called the Committee for Nuclear Energy of the Council of Ministers. In the same year, within the National Atomic Physics Institute, the Commission for Guidance and Control of the Nuclear Units was created, thought to be a control organism regulated by the Commission of Nuclear Energy.

The Commission changed the name to CNCAN in 1990 by *Decree no. 29/1990*. In that period CNCAN is under the control of the Ministry of Environment. In 1998 CNCAN became an independent body (*Law 16/1998*).

In 2001, CNCAN moves back under the responsibility of the Ministry of Environment. From 1998 until 2001 CNCAN coordinates the National Environmental Radioactivity Surveillance Network (NERSN). By the Governmental *Decision no. 894/2003* and *Law 193/2003*, CNCAN enters under the direct responsibility of the Prime Minister and it becomes, again, an independent body.

According to the *Law 111/1996*, on the safe deployment, regulation, authorization and control of nuclear activities, republished, CNCAN is the national competent authority in the nuclear field, with duties in regulation, licensing and control of nuclear practices. It has the following tasks, in particular in the field of environmental radioactivity monitoring:

- to issue regulations for the detailed specification of the general requirements for protection against ionizing radiation, including the procedures for licensing and control activities in the nuclear field;

- to establish, whenever necessary, dose constraints for practices or for certain radiation sources within a practice;
- to examine and approve the siting and construction of nuclear facilities, from the radiation protection point of view;
- to accept the commissioning of nuclear facilities with potential contamination outside their own perimeter, only if the appropriate measures on radiation protection have been taken, according to the demographic, meteorological, geological, hydrological and ecological conditions;
- to assess and approve, during the licensing process, the derived emission limits and monitoring programs of radioactive effluents, proposed by the applicant and to verify their observance, during the practice;
- to assess and approve, during the licensing process, the environmental radioactivity monitoring program proposed by the applicant;
- it may deploy its own environmental radioactivity monitoring programme in the vicinity of the nuclear / radiological facilities that could have a significant environmental impact, in order to verify the validity of data reported by the licensee.

CNCAN has specific responsibilities in radiation emergency situations. According to the *Governmental Ordinance 21/2004* and the *Governmental Decision 2288/2004*, CNCAN's main support functions in emergency situations are:

- Monitoring of specific dangers and risks, together with their associated negative consequences,

and

- Informing, notifying, measuring and alerting via the CNCAN Emergency Response Centre and its laboratory for environmental radioactivity measurements, CRL. This laboratory is part of the Emergency Response Centre and belongs to the Section for Radiation Emergencies which within CNCAN is the responsible section for the radioactivity monitoring and control programmes. The Emergency Response Centre acts as support centre performing technical analysis and prognosis of emergency situations with focus on nuclear safety, radiation protection and radiological consequences.

CNCAN's head office is located in Bucharest. CNCAN is headed by a President who is also Secretary of State, under the direct responsibility of the Prime Minister (see Fig. 1).

CNCAN's laboratory for environmental radioactivity measurements in the context with nuclear facilities is situated in the village of Afumați, 6 km north-east of Bucharest.

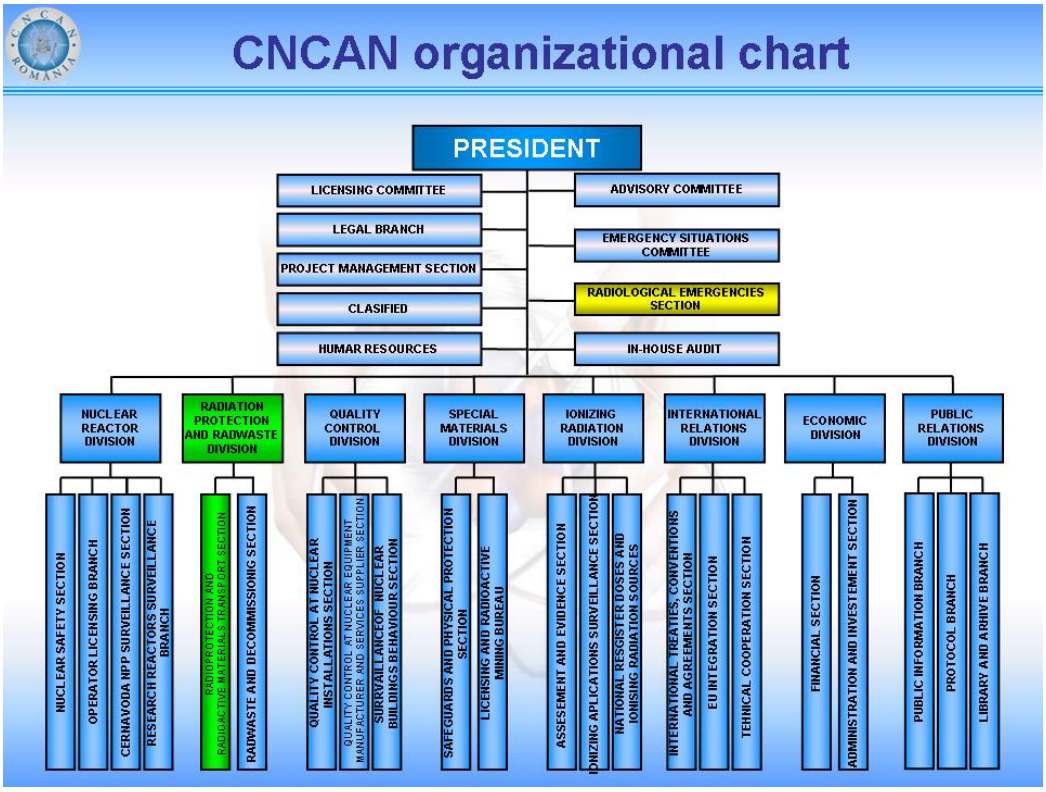

Fig. 1: CNCAN's organizational structure

5.3 MINISTRY OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT (MMDD)

The legislative framework empowers the Ministry of Environment and Sustainable Development (MMDD) for licensing practices and activities resulting in a release of radioactivity to the environment. The environmental permit issued by MMDD is based on environmental impact assessment studies and several prerequisite licenses issued by other authorities, such as: CNCAN, the Ministry of Public Health, and the Ministry of Labour, Family and Equal Opportunities.

According to the *Environmental Protection Decree no. 195/2005 (Art. 47)*, and approved by *Law 265/2006*, the Ministry of Environment, as central authority for environmental protection, is responsible for monitoring and surveillance of environmental radioactivity all over the national territory, with the general purpose of ensuring compliance with regulations, and protecting the population and the environment against harmful exposure to radiation.

In order to fulfil its legal obligations regarding monitoring and off-site emergency planning and response, MMDD organises and operates under its authority the National Environmental Radioactivity Surveillance Network (NERSN), which is a part of the National Environmental Integrated Monitoring System.

According to the above mentioned law, MMDD has responsibilities in emergency situations and co-operates with the General Inspectorate for Emergencies, the specialized organization within the Ministry of Interior and Administrative Reform, empowered to co-ordinate at national level the prevention and management of emergency situations. MMDD has representatives in the technical expert groups and also in the National Committee for Emergencies, the top-level decisional structure in emergencies.

Both the environmental monitoring stations and the meteorological network are operated under the authority of the Ministry of Environment, which has the responsibility of providing the radiological data and the meteorological prognosis in case of a nuclear accident or radiological event with an actual or potential release of radioactive material to the environment.

Specific provisions for environmental monitoring are established in *Law 111/1996*, on the safe deployment, regulation, authorization and control of nuclear activities. The main institutions under the

responsibility of the Ministry of Environment that play important roles in environmental radiological monitoring and research are described below.

5.3.1 National Environmental Protection Agency (NEPA)

Within the Ministry of Environment and Sustainable Development, the National Environmental Protection Agency (NEPA), was created as the central environment protection authority in order to ensure the technical support and to coordinate the National Integrated Monitoring System, including the National Environmental Radioactivity Surveillance Network (NERSN). In this respect, NEPA operates a reference laboratory for radioactivity (NRL), which provides the scientific and methodological coordination of the NERSN.

NEPA shall notify CNCAN and the Ministry of Interior and Administrative Reform of its findings on the monitoring activity exercised by it, and shall collaborate with these in order to set up any necessary measures to be taken.

5.3.2 National Institute for Marine Research and Development "Grigore Antipa"

The institute was established in 1970 through the unification of the existing marine research institutes within Romania. The institute is the heritage of 80 years of institutional oceanology in Romania, starting in 1926 and 1932, when the first marine research institutes were established. In 1999 it was reorganized as National Institute for Marine Research and Development "Grigore Antipa", based on the *Governmental Decision 686* of 23.08.1999. According to this legal act, the institute is the technical operator of the national scientific network for marine waters and for coastal erosion surveillance. It carries out basic, applied and technological research, with emphasis on the coastal zone and marine environment of the Black Sea. The institute implements also the national marine strategy and is part of the regional and European marine projects.

5.4 MINISTRY OF PUBLIC HEALTH (MPH)

In accordance with *Law 95/2006,* the Ministry of Public Health (MPH) is the central authority for public health, coordinating public health assistance.

In Romania, responsibility is established according to the provisions of the *Nuclear Law 111/1996, Art.39* on the safe deployment, regulation, authorization and control of nuclear activities. According to this Law, the Ministry of Public Health is responsible for organising the monitoring network of the radioactive contamination of food products, over the whole food chain, including drinking water, as well as other goods designated to be used by the population.

Its main responsibilities in addressing environmental monitoring and public health issues are:

- Environmental health monitoring;
- Issuing health regulation or advising regulation with public health impact;
- Coordinating controls and inspections for regulation enforcement;
- Acting as regulatory body for goods with potential health impact;
- Elaboration of public health programmes, financing and coordination of implementation.

For the accomplishment of these tasks MPH is supported by a network of:

- Four Public Health Institutes (IPH) in Bucharest, Iaşi, Cluj, and Timişoara;
- Two Centres in Târgu Mureş and Sibiu, with activities covering regional areas,
- The national network of 42 local Public Health Authorities (ASP), responsible for local implementation of national policy and programmes for public health. Nineteen of the ASPs include in their structure laboratories for radiation hygiene dealing with ionizing radiation measurements for specific districts.

The Ministry of Public Health shall inform CNCAN and other interested ministries of its findings within its monitoring activities, and collaborate with these in order to establish the joint actions called for.

5.5 NATIONAL SANITARY VETERINARY AND FOOD SAFETY AUTHORITY (ANSVSA)

According to the *Governmental Decision no. 130 of 29.01.2006* on the organisation and functioning of the National Sanitary Veterinary and Food Safety Authority (ANSVSA), as published in the Romanian Official Bulletin OG no. 90, 31.01.2006, this is a specialized institution of the central public administration, and the regulatory authority in the area of sanitary, veterinary and food safety. ANSVSA is under the Government subordination and under the coordination of the Ministry of Agriculture, Forests and County Development.

ANSVSA has the following tasks:

- Strategy, with the view to ensure and guarantee animal health and protection, public health, animals protection, environmental protection and food safety;
- Regulation, for the setting-up of the legal framework and elaboration of regulations (specific for the activities in the areas of sanitary-veterinary and of food safety);
- Administration of structures to coordinate and manage the sanitary-veterinary and food safety services all over the country;
- Official surveillance and control of the market.

The activities of ANSVSA are illustrated in several annual programmes approved by the ANSVSA's President, such as:

- Strategic Program for Sanitary Veterinary Surveillance;
- Program for surveillance actions, prevention and control of animal diseases, diseases transmissible from animals to humans, animal and environment protection for 2006;
- Program for surveillance, prevention and control in the field of food safety for 2007.

ANSVA has the following structure:

- The main body within ANSVSA is the Institute for Hygiene and Veterinary Public Health, located in Bucharest, which includes the Laboratory of Nuclear Analysis Techniques;
- At county level Sanitary Veterinary and Food Safety Directorates have been installed. Within these, 14 territorial laboratories operate, spread over the Romanian territory, to perform radioactivity analysis;
- At local level zonal sanitary veterinary and food safety units ("*circumscripţie*") exist.

6 MONITORING OF RADIOACTIVE DISCHARGES AND ENVIRONMENTAL RADIOACTIVITY AT THE CERNAVODĂ NPP

6.1 INTRODUCTION

The Cernavodă NPP is a state-owned company reporting to the Ministry of Economy and Commerce. The NPP is registered as *Societatea Națională Nuclearelectrica S.A.* (SNN S.A.).

The NPP is situated in the Dobrogea area, in the vicinity of the town of Cernavodă; the town counts approximately 20 000 inhabitants. The natural cooling system is provided by the right arm of the Danube River and by the Danube-Black Sea canal.

The Cernavodă NPP was initially planned to include five units. Presently only one unit is in operation and the second one in pre-operational tests.

SNN S.A. has three divisions:

- CNE *PROD* Cernavodă, operating Unit 1 and the auxiliary services.
- CNE *INVEST* Cernavodă, including Unit 2 and units 3 to 5 preservation
- *FCN* Piteşti, the nuclear fuel plant, qualified manufacturer for CANDU type 6 nuclear fuel that fully covers the needs of the Cernavodă NPP operation.

Construction of unit 1 started in 1982; it was connected to the electric power grid on 11 July 1996, the commercial operation started on 2 December of the same year. Several governmental bodies issued licenses for the Cernavodă NPP. The first operational license, issued by CNCAN on 30 July 1997, was probationary; the final operational license by CNCAN was issued on 28 April 1999. On 30 April 2001 CNCAN issued the second license for operation, followed by the third license for operation on 1 May 2003. On 23 August 2005 the Romanian Government issued the Environment license no. 2.

In 2003, the International Certification Network *IQNet* and the Romanian Society for Quality Assurance certified the NPP's environmental management system for the production of electrical and thermal energy using nuclear technologies according to ISO 14001.

Construction of Unit 2 started in 1983. By the end of 2005, Unit 2 was 90% completed and 50% of the systems reached the commissioning test phase. On 6 May 2007, the first criticality of the reactor was achieved.[4]

Construction of Unit 3 started in 1984 but was halted in 1990. It is presently under preservation, with no progress since 1992. The overall completion factor is almost 15%, consisting mainly of civil works for reactor containment, turbine building and service buildings. Only few equipment and materials are already supplied. The completion of Unit 3 is foreseen through a project company with private, local or foreign investors, without state guarantees.
Feasibility studies concerning Unit 3 have been done in 2003. In 2005, taking into account the new decision of simultaneous completion of Unit 3 and Unit 4 , a new feasibility study started and was completed in 2006.

Cernavodă NPP has the following partners for equipment and materials: *AECL*, Canada; *Ansaldo Energia*, Italy; and *General Electric*, USA.

The two operating Cernavodă NPP units are based on CANDU 6 technology. The energy output is 2180 MW_{th} respectively 706.5 MW_{el} each. Together they cover some 10 to 12 percent of the national electricity consumption. The reactors use natural uranium as fuel (380 horizontally organized fuel channels) and heavy water as moderator and coolant, in two independent closed systems. Four vertical steam generators build the link to the secondary circuit (light water). The turbines consist of one medium and three low pressure cylinders. Cooling water for steam condensation comes directly from the Danube River.

[4] Unit 2 was connected to the electric power grid on 7 August 2007. The ten days full power operation test was completed on 26 September 2007. Commercial operation started on 31 October 2007.

Appendix 3 contains the monitoring and sampling provisions for the environmental surveillance of the NPP Cernavodă. Appendix 4 gives an overview of the NPP's discharge and environmental monitoring programme; Appendix 5 shows some details of the environmental monitoring programme.

6.2 MONITORING OF RADIOACTIVE DISCHARGES

6.2.1 General

The control system for radioactive discharges during operation of the NPP follows *Law no. 111/1996* and several *CNCAN orders and licenses for operation and environmental control* around Cernavodă NPP.

CNCAN approves the documentation regarding the derived emission limits (DEL), the radioactive liquid and gaseous effluent monitoring program and the environmental radioactivity program issued by the NPP.

In order to ensure that emissions of radionuclides in gaseous and liquid effluents are below regulatory limits, a program of control and monitoring is implemented, as required.

6.2.2 Liquid discharge monitoring

Radioactive liquid waste is collected in five liquid effluent holding tanks (approximately 50 m^3 each). The contents of any tank can be discharged to the Danube or to the Danube - Black Sea Canal if the release will not exceed authorized limits. In the case of discharges to the Danube – Black Sea Canal, a prior notification has to be sent to CNCAN, the district Public Health Authority and the Regional Environmental Protection Agency.

Prior to pump-out the contents of the tank are recirculated to ensure good mixing. A grab sample is taken to the plant chemistry laboratory for analysis of tritium and gamma activity.

An estimate is made in terms of monthly derived emission limits for this pump-out, and the analysis results are sent to the shift supervisor for review. The shift supervisor may authorize pump-out if an individual tank contains less than certain limiting values for gamma activity and for tritium and if the estimated total for the month is less than 3% of the annual derived emission limit. Otherwise, approval of the station health physicist is required for the pump out.

During the pump-out, the Liquid Effluent Monitoring (LEM) system automatically monitors the gross gamma activity being discharged, and terminates the pump-out if a preset count rate is exceeded or if a malfunction occurs in the LEM. Alarms are triggered on the LEM control panel. LEM also collects a time-integrated sample from the discharge line for subsequent laboratory analysis of the actual release.

Operations staff is responsible for changing the collecting beaker of LEM after each pump-out and to record pump-out data (tank identification, date of pump-out, tank content).

If the LEM sample or the measurement data are not available the liquid effluent releases will be reported based on measurement data from grab sample analysis performed by the chemical laboratory prior to pump-out. In the case of a lack of data about the discharged volume, the liquid effluent releases will be reported based on maximum tank level.

The samples collected by the LEM over a day are taken to the NPP's health physics laboratory for detailed radionuclide analysis (gamma spectrometry, tritium and C-14 determination). Gross beta analysis is done on weekly composites; these data are used only for qualitative purposes.

The results of the above mentioned analysis constitute the official release results for the station. At the end of each month, an official summary of the releases, including the percentage of the derived emission limits (%DEL), of the previous month and %DEL released for the year to date, is issued by the Health Physics Technical Services. The monthly summary is also included in the Quarterly Station Report. Analytical requirements are shown in table 1.

Table 1: Analytical sensitivity requirements for liquid effluents

Radionuclide/ Radionuclide's group	Minimum Required Sensitivity (Bq/l)	Radionuclide/ Radionuclide group	Minimum Required Sensitivity (Bq/l)
H-3	1E + 02*	Sb-125	8.28E+00
C-14	4.97E+00	I-131 (mfp)	5.04E+00
Cr-51	1.59E+03	I-132	4.74E+02
Mn-54	1.23E+01	I-133	1.07E+02
Fe-59	1.22E+01	I-134	1.36E+03
Co-58	2.15E+01	I-135	1.43E+02
Co-60	8.56E-01	Cs-134	2.60E-01
Zn-65	2.96E+00	Cs-137	2.66E-01
Sr-89	2.04E+01	Ba-140	2.58E+01
Sr-90+	5.37E-01	Ce-141	9.28E+01
Zr-95+	2.19E+01	Ce-144	1.07E+01
Nb-95	7.83E+01	Eu-152	8.28E-01
Mo-99	2.68E+02	Gd-153	1.09E+02
Ru-103	9.72E+01	Eu-154	1.12E+00
Ru-106+	8.44E+00	Te-132	1.70E+01
Sb-122	7.39E+01	Ag-110m	5.21E+00
Sb-124	1.84E+01	Hf-181	6.17E+01

* … as required by Commission Recommendation 2004/2/EURATOM of 18 December 2003 (5)

I-131 (mfp) … mixture of fission products; for reasons of a conservative approach, it is assumed that at the recipient I-131 is in an equilibrium mixture with the other fission product radioiodines in the ratio I-131: I-133: I-134: I-135 = 1.00: 1.45: 2.00: 2.04: 1.81

+ … including activity of decay product

6.2.3 Gaseous discharge monitoring

Potentially contaminated air in the ventilation system comes from four sources:

- Central contaminated exhaust system: the air from this system is filtered through a HEPA filter;
- Reactor building exhaust system: the air from the reactor building is passed through a HEPA pre-filter, an activated charcoal filter (to retain radioiodine) and a final HEPA filter;
- Spent fuel bay exhaust system: filtration of this air is similar to that of the reactor building;
- Upgrader tower exhaust system: air from this system is unfiltered since it contains tritium only.

All potentially contaminated exhaust air is routed to the exhaust stack which disperses it to the environment. The Gaseous Effluent Monitor (GEM) is designed to monitor the release of radionuclides from the ventilation exhaust stack by routing and to automatically extract a sample for analysis. Air is drawn continuously by an isokinetic system from the exhaust duct and is analysed for particulate, radioiodine and noble gas activity. GEM triggers an alarm when predefined release levels are exceeded.

The GEM system consists of the following: 4 pumps, 3 flow transmitters, 2 passive collectors (HTO & C-14), 3 monitors (particulate, iodine & noble gas), an electronic cabinet (including a microprocessor). The particulate and radioiodine filters are changed every 24 hours as also are the tritium molecular sieve and C-14 collectors.

5 Commission Recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation, published in the OJ L-002 of 06/01/2004, page 36: http://ec.europa.eu/energy/nuclear/radioprotection/doc/legislation/2004_2_en.pdf

In case of high activity alarm, the particulate filter and the charcoal cartridge must be replaced by the operator. The filters removed are taken to the chemistry laboratory for analysis by gamma spectrometry. Based on filter analysis and noble gas readings, the total released activity up to alarm is evaluated and staff analyses what measures have to be taken.

Noble gases are not collected. The GEM monitor measures and integrates noble gas releases directly through a noble gas detector, consisting of two detection channels (one low range channel operated by a scintillation counter and a high range channel that consists of a sensitive Geiger-Müller detector). Periodically, the chamber is purged with fresh air and the same detector is used to measure background radiation.

GEM cannot measure the activity of released C-14. In the C-14 sampler, air from the stack effluent is bubbled through a NaOH solution and then analyzed by the health physics laboratory. The NaOH solution is changed every 24 hours.

Operations staff is responsible for the particulate and iodine filter change and reading the GEM indications according to the approved procedures. Health physics staff is responsible for permanent collection of samples, changing the water vapour and CO_2 collectors, and for normal routine, except for noble gas monitors. A detailed analysis of the samples is provided in the health physics laboratory (gamma spectrometry and gross beta for the particulate filters, gamma spectrometry for the charcoal filter, tritium measurements from the molecular sieve and C-14 analysis using a liquid scintillator).

Analytical requirements are shown in table 2.

Table 2: Analytical sensitivity requirements for gaseous effluents

Radionuclide/ Radionuclide group	**Minimum required sensitivity (Bq/m^3)**	**Radionuclide/ Radionuclide group**	**Minimum required sensitivity (Bq/m^3)**
H-3	1E + 03*	Ru-103	8.28E-02
C-14	1E + 01*	Ru-106+	5.52E-03
I-131 (mfp)	7.71E-04	Ag-110m	2.02E-02
I-132	5.07E+01	Sb-122	1.45E-01
I-133	1.17E+00	Sb-124	2.14E-02
I-134	2.44E+02	Sb-125	4.08E-02
I-135	1.52E+01	Te-132	4.55E-02
Cr-51	1.69E+00	Cs-134	3.01E-03
Mn-54	6.92E-02	Cs-137	1.40E-03
Fe-59	1.41E-02	Ba-140	2.75E-02
Co-58	5.78E-02	Ce-141	7.54E-02
Co-60	6.56E-03	Ce-144	7.00E-03
Zn-65	6.79E-03	Eu-152	6.98E-03
Sr-89	1.38E-02	Gd-153	1.61E-01
Sr-90+	1.36E-03	Eu-154	8.59E-03
Zr-95+	6.22E-02	Hf-181	1.75E-02
Nb-95	4.75E-02	Noble gases	2 E+04 ($BqMeV/m^3$)

* … as required by Commission Recommendation 2004/2/EURATOM of 18 December 2003 (footnote 5)

I-131 (mfp) … mixture of fission products; for reasons of a conservative approach, it is assumed that at the recipient I-131 is in an equilibrium mixture with the other fission product radioiodines in the ratio I-131: I-133: I-134: I-135 = 1.00: 1.45: 2.00: 2.04: 1.81

+ … including activity of decay product

As required by the NPP's radiation protection regulations, the station health physicist shall notify CNCAN as soon as possible in the case the gaseous emissions exceed the approved limits, for a reporting week.

An official report of gaseous effluent releases is produced weekly by the radioprotection technical service. A weekly summary table is also included in the Quarterly Station Report.

If GEM data or sample measurement results are not available, the reports are generated based on the measurement from the chemistry laboratory or based on averages of release rates before and after unavailability multiplied by the period of unavailability.

The GEM/LEM readings, the gamma spectrometry, tritium, gross beta analysis reports, are considered to be temporary records. These are kept for one year in the Health Physics Technical Service; after that they are transferred to the Operating Document Control (ODC) archive.

The weekly and monthly approved reports for gaseous and liquid effluents discharges are considered to be permanent records. These types of records are kept for five years in the Health Physics Technical Service. After that they are transferred to the ODC archive.

Electronic records organized as computer database are considered to be permanent records. An annual copy on electronic support (CD-ROMs) is made and transferred to the ODC archive.

6.2.4 Discharge control at the control room

The control room of the Cernavodă NPP contains the control and commanding devices for all monitoring paths. There is an on-line monitoring system in place which processes data on behalf of the control operations. The system is able to generate alarms.

6.2.5 Dosimetry laboratory

General

The dosimetry laboratory employs seven persons and operates a large portion of discharge samples from the NPP as well as the samples stemming from the environmental monitoring programme as performed by the operator. Measurements of samples with potentially high activity are performed in the Chemistry Laboratory of the NPP, as well as measurements related to the personnel dosimetry programme. The laboratory has no ISO 17025 accreditation but it is 'notified'[6] by CNCAN since 1996.

Sampling and determination of liquid discharges is following the IDP-RP-036 operating procedures for Unit 2 and the IDP-RP-032 operating procedures for Unit 1.

Gamma spectrometry

The laboratory equipment consists of a *Canberra* gamma spectrometer, with *Genie PC 2000* for analysis.

The system is submitted daily to a QA control and to an annual calibration. The standard sources used are *IFIN-HH* and *Amersham* produced.

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[6] According to CNCAN and following the definition in the Fundamental Norms, 'notified' refers to: a body responsible for the calibration and verification of instruments used in the personnel dosimetry surveillance, reading and interpretation of their indications, for radioactivity measurements in the human body and the biological samples and for the evaluation and attribution of doses, whose capacity to act in this respect is recognised by CNCAN.

According to the Norm *NSR-21* art.12 (2) “the licensee must ensure the monitoring of radioactive effluents through a radioactivity measurements laboratory recognised by CNCAN”, meaning a testing laboratory “designated as a body notified for the nuclear field”; according to *NSR-08* art.23 and annex 1 (2), a testing laboratory asking the designation must be evaluated, based on an ISO 17025 audit and the assessment of documents proving the observance of the applicable requirements).

Alpha and beta measurements

The laboratory is equipped with a *Canberra* alpha/beta counter type *HT 1000W*. The system is submitted daily to a QA control and to an annual calibration. The standard sources used are produced by *IFIN-HH*.

The laboratory has also two *Canberra TRI-CARB* liquid scintillation counters, which are submitted to a daily QA control. Standard sources used are from *Canberra*.

All the above mentioned devices are connected to the NPP electrical back-up supply circuit and to a UPS battery in case of unexpected electric current failure.

Similar back-up systems will be available also in the dosimetry laboratory of Unit 2.

TLD

The reading of the environmental TLDs is performed with two *Panasonic* TLD system *UD-710A* automatic readers and *UD-804 AS* dosimeters. The TLDs are calibrated annually. The calibration coefficients of the instrument are checked before each new measurement cycle. The standard method used is the irradiation of QC-TLD's at a Cs-137 primary and secondary standard source at the national authorised laboratories. The maintenance of the *Canberra* and *Panasonic* measuring systems is performed by the respective companies, based on service contracts.

Quality assurance

The measurement results are archived both as a hard copy and in a database.

The samples are stored in fume hoods one week after measurement (until discharge).

The quality assurance and control procedures are put in place by fulfilling the daily QC (Quality Control) control based on the manufacturer software (using test sources).

Intercomparison exercises

Since 1999, the laboratory participates in the following international intercomparison and proficiency tests:

- IAEA intercomparison exercise for *Panasonic* TLD, 1999;
- IAEA intercomparison exercise for gamma spectrometry in urine, 2000;
- PROCORAD, intercomparison exercise for tritium in urine, C-14 in urine and gamma spectrometry in urine, 2001-2007.

The Dosimetry Laboratory is a member of *'l'Association pour la Promotion du Contrôle de Qualité des Analyses de Biologie Médicale en Radiotoxicologie'* (PROCORAD) since 2001.

6.3 OPERATOR ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

The site related environment routine monitoring programme is implemented by the Health Physics Department within the NPP. The routine environmental monitoring programme is aligned to the specific derived emission limit document implemented by Cernavodă NPP; it consists of on-site and off-site monitoring.

6.3.1 On-site monitoring

Appendix 6 shows the on-site monitoring locations.

6.3.1.1 Vegetation and soil samples

The NPP operator performs vegetation and soil sampling at two locations.

6.3.1.2 Air

Near the Intermediate Dry Spent Fuel Storage Facility the NPP operates an air sampler (*F&J specialty products* (USA) with *F&J* digital flow integrator; 0.12 kW *GAST* (UK) pump; flow rate control by *F&J* rotameter).

A second inlet is used for tritium sampling on two molecular sieves, using a metallic pre-filter and a humidity control device.

Iodine is sampled on an activated charcoal cartridge (changed every 3 months). Particulate filters are changed monthly.

6.3.1.3 Dose rate and dose

At the Unit 1 site perimeter 24 locations have been selected for TLDs. At the Intermediate Dry Spent Fuel Storage Facility 12 TLDs are installed. The dosimeters are changed and read every 3 months. The TLDs (*Panasonic*) are mounted in LSC vials attached outside the air sampler cabin.

6.3.1.4 'Ground' water

Ground water and seeping rain water is collected in a vault near the (generally locked) entrance to the intermediate waste facility site.

6.3.1.5 Meteorological information

The meteorological station is located on a small hill approximately three km from Unit 1. It provides data on wind speed, wind direction, ambient temperature and humidity, elevation temperature differences, rainfall quantity, solar radiation (net and global), atmospheric pressure and send these data in the main control room and secondary control area (via the NPP's network and it is available at any workstation).

The meteorological parameters are measured in two separate locations of the station.

- on the meteorological tower sensors for wind speed, wind direction and air temperature are located at heights of 10, 30 and 80 m.

- on the roof of the administrative building a rain sensor is located, far enough from the tower to minimize interference.

The data acquisition unit, the radio transmitter and the data acquisition power supply are located inside the switchyard of the meteorological building.

Additionally, the National Institute of Meteorology and Hydrology (INMH) provides daily prognoses to the NPP and offers on a monthly basis a meteorological forecast for the Cernavodă area.

6.3.2 Off-site monitoring

The NPP operates a continuous off-site monitoring system, including dose rate monitors in selected locations situated outside the plant perimeter in so called "indicator stations". Additionally, in various locations different types of samples are taken. The off-site monitoring has a perimeter of 30 km. Samples are measured in the NPP's laboratory for environmental sample analysis in Cernavodă town.

Sampling / monitoring locations, emission categories and specific nuclides, monitoring frequencies and analytical frequencies corresponding to the Cernavodă NPP environmental programme are presented in Appendices 4 to 5 and7 to 9.

In addition to the routine monitoring program, the NPP implemented several supplementary ones. These programs are not required for any technical reasons under normal plant operating conditions. They may be initiated mainly to provide reassurance to the public by responding to its perception of risk; and to provide adequate dose assessments in the event of major emissions.

Their implementation, depending on the specificity of the program may include:

- sampling from different locations as provided in the routine environmental radiation monitoring program;

- sampling and laboratory analysis performed more often as provided in the routine monitoring program;
- performing specific analysis for determination of certain specific radionuclides.

In the case of major radioactive releases from the plant, these supplementary programs will be implemented using resources and an organisation established according to the One-Site Radiation Emergency Plan.

Some specific sample and monitoring types are described below.

6.3.2.1 Air

Appendix 7 shows the location of air samplers. One of them is located within the premises of the NPP's environmental laboratory in Cernavodă town, another one at a large abandoned milk farm on a hill south of the village of Seimeni. The area is fenced-in. The same types of devices are used as described for the on-site system in chapter 6.3.2.

6.3.2.2 Dose and Dose rate

Currently only TLD devices are installed (61 in total; on and off site), automatic dose rate monitors have not been set up. The NPP plans to purchase firstly 4 gamma dose rate probes to be installed within the 10 km perimeter. Maps showing the locations are presented in Appendices 7 and 8.

6.3.2.3 Drinking water

Drinking water is collected and measured on a regular basis.

6.3.2.4 River water

Danube River water upstream and downstream of the outlet from the NPP is sampled every Monday and Friday using a boat belonging to the operator. The schedule is adapted with regard to the cleaning schedule.

6.3.2.5 Sediment

Danube River sediment samples are collected twice per year at Cernavodă (from the bridge) and at Seimeni.

6.3.2.6 Precipitation

Precipitation is sampled monthly.

6.3.2.7 Fish

Danube fish is bought from local fishermen twice a year, catfish being seen as a good indicator. Fish from two fish farms at Lake Domneasca and Lake Baciu is bought in March and October (from April until September fishing is not allowed). The fish from that fish farm are better indicators because they are strictly local; no migration unlike the fish from the Danube river.

6.3.2.8 Meat and Milk

Meat samples come from two farmers in the area, based on an agreement; the laboratory receives meat after slaughtering.

Milk sampling is performed weekly; meat is collected once per year.

6.3.2.9 Vegetables

Vegetables and fruit are sampled every month, depending on harvestable produce: e.g. salad (April/May), onions (April/May), spinach (April/May), cherries (June), peach.

The samples are grown by local producers and bought at the market (also in Cernavodă) by authorised sellers.

6.3.3 Operator's environmental control laboratory

General

The laboratory is situated in the town of Cernavodă, close to the centre. Altogether 8 persons work in the lab (2 engineers, 5 technicians, one person for sampling). Every staff member is trained on every task performed but has his specialty. A specialist for checking calibrations is available; the first calibration of measuring devices was done by the Metrological Institute Bucharest. Through-put of the laboratory is about 1000 samples per year.

The Environmental Control Laboratory of the NPP is responsible for the implementation of the Environmental Radioactivity Monitoring Programme at Cernavodă NPP. The capability of the laboratory to perform radioactivity determinations in environmental samples was recognised by CNCAN, as requested by the applicable regulations, in 2007, when this laboratory was designated as "testing laboratory for the nuclear field", based on an ISO 17025 audit.

Sample registration

The samples come to the laboratory together with a completed sampling sheet (sample type; sample location; name of sampling person; date and time of sampling; sample "quantity" etc.). They are registered in the sample register receiving a unique number. The sample recording sheet contains all the information regarding the collection coordinates, type of measurements to be performed, the preparation and the measurement details. All information is available on paper and in a database.

Sample preparation

Milk and water samples are transferred to a 4-liter Marinelli beaker, vegetation samples are put into 0.5-liter Marinelli beakers. For beta measurements samples are ashed and fixed on the measuring trays. Samples for C-14 measurement by LSC are prepared using a special combustion method of Canadian design.

A description of equipment available and quality management issues is given in Chapter 9.1.8.

6.4 INDEPENDENT CONTROL BY THE REGULATOR

6.4.1 CNCAN laboratory in Afumați

For the environmental samples around the NPP, independent measurements are provided by CNCAN's laboratory for environmental radioactivity (CRL), situated at Afumați (Bucharest). This laboratory performs measurements of samples not only from Cernavodă, but also from other regions in Romania. The laboratory functions in the Section for Radiation Emergencies within CNCAN's Emergency Response Centre. It performs the ongoing NPP related radioactivity monitoring and control programmes by doing sampling, sample preparation and analysis. The Section for Radiation Emergencies reports directly to CNCAN's President. The monitoring and control programme performed by CNCAN in the area of the Cernavodă NPP started in 1998.

According to the Environmental Radioactivity Monitoring and Control Programme around the Cernavodă NPP, various media are sampled and measurements are performed. This program is elaborated annually and has to be approved by CNCAN as part of the "Annual Plan for inspections in the off-site environment of nuclear installations". CNCAN's laboratory analyses environmental and foodstuff samples such as: air, precipitations, surface water, vegetation, soil, agricultural soil, milk, vegetables and fruit. Details about the programme and sampling locations are given in appendices 10 respectively 11.

6.4.2 NERSN's monitoring programme in the influence area of Cernavodă

The National Environmental Radioactivity Surveillance Network (NERSN) is made up of the Reference Laboratory for Radioactivity (NRL) of the National Environmental Protection Agency (NEPA) at Bucharest and the Survey Stations for Radiological Monitoring (SSRMs) of the various Local Environmental Protection Agencies (LEPAs) that themselves are controlled by NEPA.

NERSN laboratories from Cernavodă, Constanța, Călăraşi and Slobozia, under the co-ordination of NRL, are performing a monitoring programme in the influence area of Cernavodă NPP.

Surface and drinking water

Details with regard to the surface water monitoring programme performed by SSRM Cernavodă (which belongs to LEPA Constanța) are given in table 3 below.

Table 3: Cernavodă NPP related surface water monitoring programme; sampling performed by SSRM Cernavodă

Sampling station	**Beta global**			**Gamma spec.**	**Tritium and C-14**		
	Quantity	**Measurement**	**Report**	**Quantity**	**Sample expedition**	**Quantity**	**Sample expedition**
Channel Seimeni	1 L/ day	1 L/ immediately	Monthly	3L/day	Monthly	300 mL/ day	Weekly
Channel Ecluză	1 L/ day	1 L/ immediately	Monthly	3L/day	Monthly	300 mL/ day	Weekly
Danube-Gara Fluvială	1 L/ day	1 L/ immediately, 5 days	Daily	3L/day	Monthly	300 mL/ day	Weekly
Danube-Seimeni	1L/ Week	1 L/ immediately, days	Monthly	20 L/month	Monthly	300 mL/ week	Week
Danube branch. Borcea – Feteşti	1 L/ month	1 L/ immediately, 5 days	Monthly	20 L/month	Monthly	300 mL/ trim	Trim.
Danube – Cochirleni	1 L/ month	1 L/ immediately, 5 days	Monthly	20 L/month	Monthly	300 mL/ month	Monthly
Danube – Capidava	1 L/ month	1 L/ immediately, 5 days	Monthly	20 L/month	Monthly	300 mL/ month	Monthly
Channel D-MN Medgidia	1 L/ month	1 L/ immediately, 5 days	Monthly	20 L/month	Monthly	300 mL/ month	Monthly
Channel D-MN Saligny	-	-	-	-	-	300 mL/ day	Week
Lake Domneasca	-	-	-	-	-	300 mL/trim.	Trim.
Lake Baciu	-	-	-	40 L/year	Yearly	-	-

For drinking water the SSRM Cernavodă collects daily, from Cernavodă town, one litre for total beta analysis. Gamma spectrometry is done on a monthly basis. In addition, one litre sample from Feteşti town is collected weekly, the measurements being performed monthly.

For all the waters the monthly residue is analysed by gamma spectrometry by SSRM Constanța and for tritium by SSRM Cernavodă.. The results are reported to NRL in Bucharest.

Precipitation

Every week 300 ml per day are sampled in two locations, at Cernavodă and Medgidia, and a beta measurement is performed.

Groundwater

For ground water sampling there are two wells around the NPP perimeter. One litre of water for total beta and 3 litres for gamma spectrometry are collected daily by NERSN laboratories.

Soil

There are 10 sampling locations for uncultivated soil and 3 locations for cultivated and irrigated soil, as part of the NERSN programme.

Vegetation

There are 10 sampling locations for 'spontaneous' vegetation within the NERSN monitoring programme. Total beta analysis is done locally and the results are reported six monthly to NRL. For gamma spectrometry the samples are sent to SSRM Constanța twice a year. For tritium and C-14 the samples are sent immediately to NRL in Bucharest for analysis.

At 6 locations vegetables for human consumption are sampled once per year, according to the season (one kilo each), and gamma spectrometry is performed.

At 3 locations forage plants (one kg each) are sampled once per year. Gamma spectrometry and analysis of tritium and C-14 is performed by NRL.

Aquatic plants are sampled once per year from three lakes, at two points of the Danube River and at one point at each of the channels near the NPP (500 g each). Annually, gamma spectrometric analysis is performed by SSRM Constanța; tritium and C-14 analyses on these samples are performed by NRL.

Milk

From 3 local farms 500 ml of fresh goats and cows milk are sampled each month. Gamma spectrometric analysis is performed by SSRM Constanța and determination of tritium and C-14 is performed by NRL.

Fish

Fish is sampled in:

- 2 locations on the Danube River, at Seimeni, Ecluză;
- Danube – Black Sea Canal;
- the lakes Baciu, Domneasca and Făclia, near the Cernavodă NPP.

One kilo of fish is sampled yearly. Gamma spectrometric analysis is performed by SSRM Constanța and determination of tritium and C-14 is performed by NRL.

6.4.2.1 LEPA Constanța - SSRMCernavodă

Most of the Cernavodă NPP related environmental monitoring by NERSN is performed by its local – type '24 hour' – radioactivity laboratory in Cernavodă town. An exception is gamma spectrometry. Samples that have to undergo gamma spectrometric analysis are sent to SSRM Constanța.

6.4.2.2 LEPA Constanța - SSRM Constanța

NERSN's SSRM laboratory in Constanța ('24 hour' type) is involved in specific tasks with regard to NERSN's Cernavodă NPP related environmental monitoring. In particular it performs gamma spectrometric measurements.

7 NATIONAL MONITORING OF ENVIRONMENTAL RADIOACTIVITY

7.1 GENERAL

As presented in Chapter 5, continuous monitoring of environmental radioactivity on the Romanian territory is carried out by several organisations. The main part of the national monitoring is covered by the National Environmental Protection Agency (NEPA). NEPA has a reference laboratory for radioactivity (NRL), which ensures the surveillance through a national environmental radioactivity surveillance network (NERSN), consisting of ten '24 hour', one '16 hour' and twenty-six '11 hour' laboratories (SSRM, see figure 2) and through the automatic early warning system for radiation in the

environment (EWS). EWS supports routine radiological surveillance and provides monitoring data needed in emergency situations. Data from EWS are provided also to the EURDEP system.

'24 hour' programme means 4 measurement series per day; '16 hours' means three times per day; and '11 hours' signifies two times per day.

The NERSN monitoring programme of these 37 laboratories includes measurements of air, water, vegetation, uncultivated and cultivated soils, vegetables, fruit and milk.

Currently NEPA is in a process of modernisation and upgrading of the capabilities of the NERSN network and the NRL laboratory.

Fig. 2: NERSN network of 37 SSRM laboratories

The NEPA laboratory in Bucharest (NRL) organises training for the local LEPA SSRM laboratories; for this task it has technical assistance from Liverpool University, through a PHARE project.

In the laboratories the samples are stored in special storage rooms. The storage conditions and periods (approximately two years) are determined by the activity of the sample according to the lab's QA/QC procedures. There are still historical samples from 1986 in storage.

In the NERSN laboratories each day four background measurements are performed with regard to the air filters' analysis devices; a visual quality control chart allows efficient quality management. When 'higher' values than expected occur the sample has to be re-measured.

Within the PHARE project some SSRM laboratories received new equipment (e.g. Constanța only gamma spectrometry). *Sarad RTM 1688* radon/thoron monitors were delivered to several laboratories dealing with uranium mining surveillance. Generally for air sampling and measurement 'old' and 'new' systems are available in parallel. The project also included some large Pb shields, and *Thermo Scientific FHT1100* devices for total beta and alpha measurement.

Each laboratory bought its own calibration source (with certificate). Strontium sources mostly were supplied by *IFIN-HH* and are old; 17 out of 37 SSRMs have received new strontium calibration sources with certificates.

7.2 AUTOMATIC SYSTEMS

Romania operates automatic systems for the monitoring of ambient gamma dose rate all over the country and particularly at locations close to NPPs, as well as one for radioactivity surveillance of the Danube River.

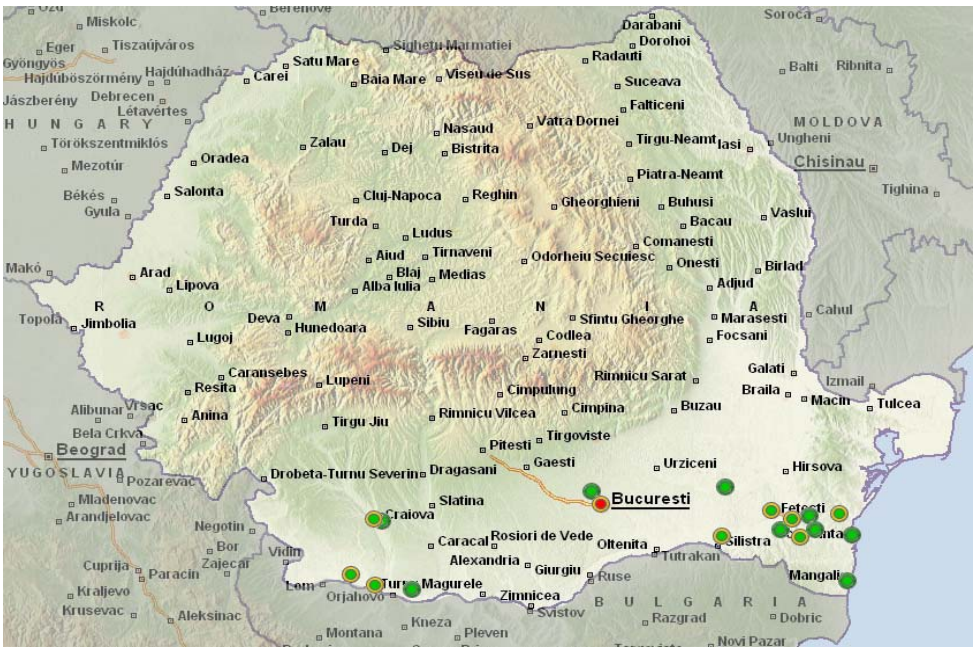

Fig. 3: NEPA's ambient gamma dose rate network in the vicinity of the Cernavodă and Kozloduy NPPs

7.2.1 Ambient gamma dose rate monitoring network

Altogether, the automatic ambient dose rate monitoring system comprises 88 stations, spread over the national territory and close to NPPs, all with real time data transmission.

Data from 49 of those ambient gamma dose rate measurement stations (early warning system) are sent daily to the EC through the EURDEP platform; an additional 39 ambient gamma dose rate measurement stations ('new' system) are still in the installation phase.

All data from the automatic ambient dose rate monitoring stations around NPP Cernavodă are transmitted to the network coordination centre of NRL; they are checked, validated, stored and forwarded to the Cernavodă NPP operator, the Cernavodă Town Administration and to the laboratories of the National Environmental Radioactivity Surveillance Network (NERSN), responsible for the monitoring of the NPP's influence area. Validated data from automatic ambient dose rate monitoring station around NPP Kosloduy are sent to the SSRM responsible for the monitoring of this area (see figure 3).

7.2.1.1 For the national territory – 'old' system

All of NERSN's laboratories still operate dose rate monitoring devices of the 'old' system, based on detectors produced by IFIN-HH (type TIEX, using GM tubes; connected to a base station). Each base station displays instant data (four second intervals) and hourly averaged data. Data transmission to NRL Bucharest is daily, by manually sending the values (thus the system is not completely automated).

7.2.1.2 For the national territory – 'new' system

The 'new' system is composed of 39 ambient dose rate monitoring stations. The dose rate probes are from *Umwelt- und Ingenieurtechnik GmbH (UIT GmbH)*, Dresden, Germany, model *HNQ24*.

Each detector consists of two GM tubes and has a measuring range of 0.03 µSv/h – 10 Sv/h. For dose rates of 10 Sv/h up to 100 Sv/h the monitor will show a minimum of 10 Sv/h.

The operating temperature range is -40 to +70^{o}C.

The device also registers some meteorological data.

The detectors can store up to 4096 gamma dose rate values. The values and meteorological data are sent to NRL as the network coordination centre using GPRS as main data link, and by satellite (*Orbcomm* System) as back-up. The gamma dose rate values are sent every 5 minutes under normal conditions and every minute in case of alarm.

For routine and alarm situations the data are sent in real time. Furthermore, they are stored in the local data base on the SSRM's PC.

7.2.1.3 For the Cernavodă and the Kozloduy area – EWS

The Early Warning System (EWS) for the NPP Cernavodă and Kozloduy influence area is composed of 49 ambient dose rate monitoring stations (see figure 4). The probes are of the *ARGUS* type, manufactured by the *Institut National des Radioéléments* (I.R.E), Belgium.

The detector consists of two GM tubes and has a measuring range of 10 nSv/h – 1 Sv/h. The operating temperature range is -40 to +55^{o}C.

The gamma dose rate values are stored in the device's data logger and in the data acquisition module of the automatic station. Data are sent to the network coordination centre at NRL by satellite (*Orbcomm System*) and stored in the data base.

Under normal conditions the system is sending a daily data package consisting of 24 values (hourly averages). In alarm mode however, the data can be sent with a frequency set by the operator.

The system provides real time early warning in case of high values recorded (radioactivity alarm).

7.2.2 Water monitoring

Within the water radioactivity monitoring network 5 submersible intelligent probes are installed along the Danube River. They are manufactured by *UIT GmbH* and use a 2"x2" NaI(Tl) detector for measurement with an Am-241 source embedded for energy stabilisation. The nominal measuring range is 10E-2 to 10E+2 MBq/m^3. Data retention of the device is 10 years. The data are stored in a local computer with 40 GB capacity and then sent to the network coordination centre at NRL by GPRS. The frequency of data transmission is programmable; in normal conditions transmission is twice a day, in emergency conditions every hour.

7.3 LABORATORY BASED SYSTEM

7.3.1 Sampling and measurement programme

7.3.1.1 Air

In 2003, through a PHARE project Romania received 18 "high volume" aerosol samplers (max. capacity 30 m^3/h). They were installed in some of the SSRM stations. The other laboratories are still using 'old' sampling devices.

The 'new' devices (type *VOPV-10*, made by *VF s.r.o.*, Slovakia) use a centrifugal pump with a processor controlled high-speed induction motor, a flow meter, a control unit, and a keyboard. A 2x16 character alphanumeric display shows the current airflow, total sampled volume from the start of the system, the sampled volume in a selectable time interval, the total number of operating hours from the start, temperature and pressure of the sampled medium, status and error messages, and the actual time. When regaining power after a power supply failure the device automatically restarts.

Connection to an external PC via an RS-485 interface is possible. The operational temperature range is from -20°C to +50°C. The device uses glass fibre filters (retention coefficient 90%). The frequency of filter change is 5 hours; there are 4 filters/day for SSRM stations with 24 hour programme, 3 filters/day for the one with 16 hour programme and 2 filters/day for the ones with 11 hour programme.

The filters are analysed in the local laboratory (total alpha and total beta). Beta measurement is performed 3 minutes, 20 hours and 5 days after the end of sampling. Gamma spectrometric analysis is performed on all filters of a month (if the local laboratory does not have the capability the filter

material is sent to a NEPA laboratory suitably equipped, e.g. Constanța, Craiova, Iaşi, Baia Mare, Arad).

Beta measurement results are reported separately in Excel format and stored centrally at NEPA Bucharest. The results are transmitted via Easy Proteo to the EC's REM database in Ispra.

7.3.1.2 Wet and dry deposition

Precipitation (dry and wet deposition) collectors are situated in the SSRM yards of Cernavodă, Călăraşi, Slobozia and Constanța and at Bucharest (Afumați). The samples are taken daily. When it does not rain, the collector is washed with 1 litre of distilled water according to the internal procedures.

In the case an analysis of tritium is foreseen if possible 250 ml of the rain sample (not the distilled water) are taken. This sample has higher priority than the ones for total beta and gamma spectrometric analysis.

For total beta analyses the remaining sample is evaporated and the residue is measured on the same day for 1000 seconds and again after 5 days for 3000 seconds.

For gamma spectrometric analyses all samples collected in one month are combined; the evaporation residue is measured at the end of the month.

7.3.1.3 Ground water

A one litre sample is collected every day. After evaporation, the residue is measured for total beta the same day, for 1000 s.

7.3.1.4 Surface water

NERSN performs surface water monitoring concerning the whole territory, as well as specifically for the Danube River. Water is collected at different locations all over Romania (see left side of figure 4). All the sampling points are situated on the rivers in the vicinity of the city. Sampling is done daily.

In the area near Kozloduy and Cernavodă, there are 4 different sampling points situated on the Danube River, as well as 5 automatic water monitoring stations, 2 of which are at Cernavodă (see right side of figure 4).

One litre samples are collected daily. For gross beta analysis the water is evaporated and the residue is measured on the same day, for 1000 seconds; after 5 days the sample is measured again for 3000 seconds.

For gamma spectrometric analyses the daily samples of a month are combined.

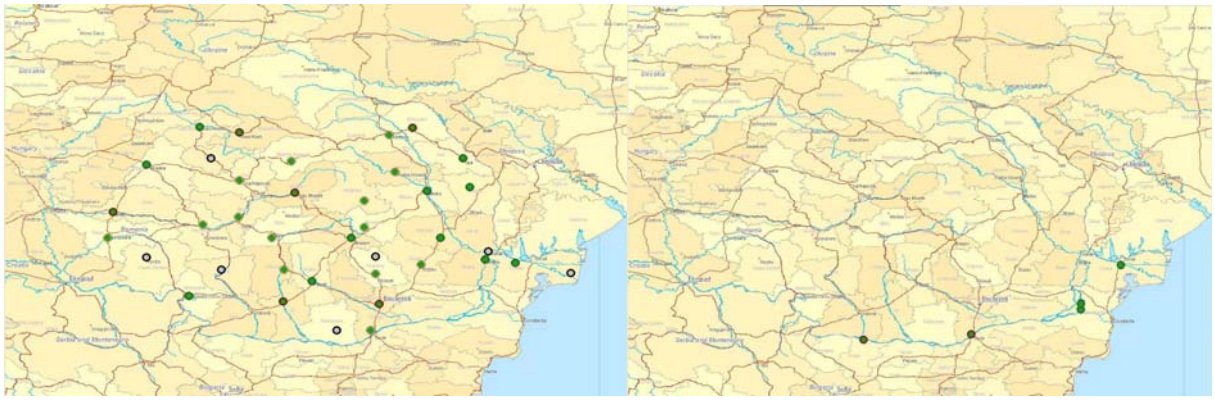

Fig. 4: NERSN's surface water radioactivity monitoring network (left side – countrywide; right side – Danube River)

7.3.1.5 Drinking water

The national monitoring is carried out by the Ministry of Public Health's (MPH) network of ionizing radiation hygiene laboratories, according to the methodology designed by the Institute of Public Health (IPH) Bucharest. Three to five litres of drinking water are sampled on a quarterly basis. For screening purposes gross alpha and beta activities and Rn-222 are measured. In cases where gross activity levels are higher than the accepted levels, K-40, Cs-137, Sr-90, Ra-226, natural uranium and in certain cases Po-210 are measured.

For nuclear facilities related monitoring, the radioactivity of drinking water is assessed monthly. For water sampled in the surroundings of the NPP, gross alpha and beta as well as tritium are measured monthly; Cs-137 and Sr-90 are determined quarterly. For water coming from a mining or a nuclear fuel processing zone, gross alpha and beta are measured on a monthly basis; natural uranium, Po-210 and Ra-226 are measured quarterly.

7.3.1.6 Soil

At the NERSN stations uncultivated soil is sampled weekly; sample size is 10 cm x 10 cm x 5 cm. The samples are dried. After 5 days a beta measurement of 3000 seconds is performed. Gamma spectrometric analysis is performed on a yearly basis (the sample from July).

7.3.1.7 Vegetation

Sampling of vegetation is done in the network's SSRM yards. Between 1st of April and 31st of October, once every week, vegetation on one square meter is collected and dried. After 5 days a gross beta measurement of 3000 seconds and gamma spectrometric analysis is performed. Additionally such sampling is performed by the food safety authorities (see Chapter 7.3.4).

7.3.1.8 Foodstuffs

According to the *Joint Ministerial Order no. 1805/286/314/2006* of the Ministry of Public Health (MPH) on the implementation of the regulation regarding radioactive contamination of foodstuff and feeding stuffs, MPH via the public health authorities and ANSVSA are responsible for:

- Monitoring the level of radioactivity of food and feed after a nuclear emergency or accident,
- Checking the imported food at borders,
- Designating the network of specialized laboratories,
- Publishing the information on those designated laboratories in the Official Bulletin.

7.3.1.9 Milk

For the national monitoring programme MPH laboratories measure 10 litres of milk from the local dairies of each of the main four regions of the country. Sampling is done quarterly. Quarterly gross beta and K-40 are measured. Yearly a gamma spectrometric analysis is performed and the content of Sr-90, Ra-226, and in some cases Po-210 is determined.

For nuclear facilities related monitoring 10 litres of milk from local farms, markets or dairies are taken on a monthly basis. Gross alpha, gross beta and K-40 are measured. On milk collected in the surrounding of the NPP a quarterly analysis with regard to e.g. Cs-137 and Sr-90 is performed. For mining or nuclear fuel processing areas, natural uranium, Po-210 and Ra-226 is measured every three months.

7.3.1.10 Mixed diet

For the national monitoring programme IPH's laboratories sample daily 2 – 3 served meals from school, kindergarten and some other canteens. On quarterly bulked samples gross beta and K-40 are determined. Yearly the content of Cs-137, Sr-90, Ra-226, and in some cases Po-210 is measured.

For nuclear facilities related monitoring the quantity and the sampling procedure is the same as above, however the measuring scheme differs. Gross beta, gross alpha and K-40 determinations are performed quarterly on the bulked samples. In the NPP area Cs-137 and Sr-90 is measured quarterly. For mining or nuclear fuel processing areas, natural uranium, Po-210 and Ra-226 are measured quarterly.

7.3.1.11 Individual foodstuffs

For the national monitoring programme, the following products are sampled annually: 7 kg meat, 5 kg fish, 3 – 5 kg cereals or flour or bread, 10 kg carrots, 5 kg cabbage, 6 kg potatoes, 5 kg tomatoes, peppers, and 10 kg apples.

The radionuclides assessed annually are: K-40, Cs-137, Sr-90, Ra-226 and in specific cases Po-210.

For nuclear facilities related monitoring the quantities are the same as above, however sampling is quarterly, only from local producers. Gross alpha and beta and K-40 are assessed. Cs-137 and Sr-90 are measured in the NPP's area. For mining or nuclear fuel processing areas natural uranium, Po-210 and Ra-226 are measured.

7.3.2 NERSN laboratories

After the Chernobyl accident in 1986 the monitoring network consisted of 47 laboratories all over the country. In 2000 it was reduced to 37.

The laboratories have different daily working time programmes. Ten laboratories work on 24 hr schedule (e.g. Bucharest, Constanța), one on 16 hr and the others work on an 11 hr schedule.

NEPA's reference laboratory, NRL, gathers the results of all gross beta measurements from the local SSRM laboratories.

NRL transmits daily reports to the Ministry of Environment and other governmental organisations.

Other results e.g. on gamma spectrometry, radon and thoron are compiled by the laboratories and a monthly report is sent to NRL.

Based on the monitoring data, NRL prepares an annual report and distributes it to the relevant national authorities. Data are also transmitted to the EC database, REM, using the Easy Proteo platform.

7.3.3 Ministry of Public Health laboratories

According to the *Ministerial Order no. 570/2007* of the Ministry of Public Health (MPH), regarding the technical norms for implementing, evaluation and financing of national programmes, a *national programme of prophylaxis* is in place.

In accordance with the *Ministerial Order no. 1688/2004* of MPH on national public health the responsible body for technical coordination and drafting the surveillance methodology for foodstuff and drinking water is the Institute of Public Health (IPH) in Bucharest.

The national public health network consists of 19 laboratories covering the entire national territory, technically coordinated by the 4 regional Institutes of Public Health. The sampling according to the national monitoring programme is detailed under 7.3.1.

7.3.4 Food safety laboratories

The Laboratory of Nuclear Analysis Techniques of the Hygiene and Veterinary Public Health Institute performs measurements of radioisotopes products of the animal origin: milk and dairy products, meat, fish, honey; as well as of feeding stuffs; forest fruit; cultivated or wild mushrooms; water used in the technological process of food processing or in animal farms; dehydrated products (additives, ingredients for food industry).

The sampling frequency is quarterly or twice a year. The samples are analysed in an ANSVSA controlled laboratory for Cs-134 and Cs-137 (Laboratory of Analyses through Nuclear Techniques belonging to the Institute for Hygiene and Veterinary Public Health in Bucharest). It is notified by CNCAN to perform such measurements, through Notification No. LI 07/2006 (expiry date 02.04.2009).

A determination of the radioactive contamination level can also be performed at the express request of physical persons. The laboratory analyses are performed by official veterinary surgeons or by state inspectors authorized for this purpose.

The radioactivity tests for food and feed (Cs-134 and Cs-137) are accredited by the Romanian accreditation body, RENAR, according to ISO 17025:2005 (accreditation certificate No. 190-L).

In 2006 over 20 000 samples were analysed, of which 9 700 samples were checked in the framework of the "Strategic program for sanitary veterinary surveillance".

7.3.5 Marine research laboratories

Romania does not operate a routine monitoring programme for marine waters and biota. However primarily within international research programmes data with regard to the Black Sea environment are gathered (see also Chapters 5.3.2 and 9.5.3).

8 FOOD IMPORT CONTROL FACILITIES

Imported foodstuffs must have a certificate concerning radioactivity levels. Customs is entitled and able to carry out sampling of imported products; analysis of samples may include also radioactivity measurements. Qualitative radiation measurements are performed by the Sanitary Veterinary and Food Safety Directorate laboratory in Constanța; the customs officials at the harbour have hand-held dose rate measurement devices for alerting. Sampling can be initiated for example by a notification through the customs early warning system. Laboratory analysis takes one or two days; containers are not delayed at the harbour during the laboratory analysis. If radioactivity is found the receiver of the shipment is notified and an alert is issued to the customs rapid alert system. The procedure has been agreed and documented, but in practise the Constanța customs has so far not carried out any samplings based on suspected radioactivity.

More details are given in Chapters 9.5.4 and 9.5.5.

9 VERIFICATION ACTIVITIES

9.1 CERNAVODĂ NPP – MONITORING BY THE OPERATOR

9.1.1 Introduction

With regard to the NPP operator's monitoring facilities the verification team carried out a verification of liquid and gaseous discharge monitoring provisions and arrangements for on- and off-site environmental radiation monitoring. The team visited the following locations:

- Sampling and on-line monitoring systems for airborne discharges at unit 2
- Control room at unit 1
- Sampling and on-line monitoring systems for liquid discharges at unit 1
- Operators analytical laboratory for discharge samples
- Operators analytical laboratory for environmental samples
- On-site and off-site environmental monitoring facilities

9.1.2 Liquid discharges

The verification team visited the liquid effluent monitoring (LEM) arrangements in Unit 1. Arrangements in Unit 2 are identical to Unit 1. The system consists of both on-line monitoring and sampling. Waste water is collected in five discharge tanks, each tank with a capacity of 50 m^3. Tanks TK1 and TK2 contain water with "high activity".

The discharge volumes are fairly high – typically there are 2-3 tank discharges of 20-40 m^3 each day. Discharge activity limits for the Danube and the Black Sea Canal have been set in the NPP operating licence. A special permission is needed for discharges in the Black Sea Canal.

A one litre sample is taken before each tank discharge for analysis in the chemistry laboratory. Samples are taken from a single sampling point with individual sampling lines to each tank. The verification team noted that there were no clear tank labels on the sampling line valves, so the sample could accidentally be taken from a wrong tank. The samples collected from the tanks are analysed in the laboratory and results reported to CNCAN on a quarterly basis. Water samples are kept until the results have been validated.

The LEM system calibration is carried out every 18 months according to the NPP maintenance plan.

In addition to individual tank samples there is an automatic system for sample collection and activity monitoring during discharge. The on-line system automatically shuts down the discharge if a predefined activity level is reached during discharge. An alarm is made locally and at the plant control room. The plant central computer maintains records of alarms; readings of the on-line activity monitor are recorded on paper. Samples collected from the tanks during the pump-out are analysed in the dosimetry laboratory and results are reported by the Health Physics Technical Services monthly to the management team and to CNCAN on a quarterly basis. Water samples are kept until the results have been independently verified and validated by the Health Physics Technical Services. A UPS power supply is available for the automatic discharge sampling and monitoring system.

A verification sample is taken on a continuous basis from the siphon basin, i.e. in the environment after the discharge has mixed with the plant cooling water. A small pump fills a sampling tank in one week; samples are taken from this tank for laboratory analysis. There is no electrical power back-up for this system.

All the procedures and instruction manuals were available at the locations visited.

The verification team suggests the discharge tank sampling line labelling be improved in order to avoid sampling from the wrong tank.

9.1.3 Airborne discharges

The verification team visited the monitoring facilities for airborne discharges (GEM) at the Cernavodă Unit 2 stack D20.

Sampling is carried out continuously by an isokinetic sampling system from the exhaust duct. Samples are monitored for particulates, radioiodine and noble gases. GEM monitors alarm when predefined release levels are exceeded. All systems in Unit 2 are new and in very good condition. It should be noted that the gaseous discharge monitoring arrangements are not identical in Units 1 and 2 since the systems have different manufacturers. However, the team was informed that the systems in the older Unit 1 will be upgraded to an identical standard with the new Unit 2.

The gaseous monitoring system (*Canberra CAM 130*) consists of gross-γ on-line measurement of noble gases, particulate and activated charcoal filters and *MARC-7000* collectors for tritium and C-14. All on-line systems have local displays and alarms in the control room. Filter papers are changed on a daily basis at midnight and collector bottles on a weekly basis. The vacuum pump of the collector system provides a controlled flow for the collectors. The pump is checked every 6 months. System calibration is carried out according to the NPP maintenance plan every 12 months. The instrumentation panels are checked every 18 months.

There is also a semiportable back-up system (*PIG FF*), provided with its own pump (28 litres/min).

In addition to these systems there is a system for measuring stack flow, temperature and humidity. A *Fuji Electric FCX AII* type pitot head is fitted inside the stack to measure the flow rate, connected to a flow transmitter. The pitot head transmits also information on the temperature and humidity in case of an emergency.

All the procedures and instruction manuals were available at the locations visited.

The Health Physics Technical Services independently verifies the results of the analysis, calculates the noble gas emissions, validates the results and prepares weekly gaseous emissions reports to the management team. These values are included also in the Quarterly Station Report.

The monthly reports are kept in the health physics technical service for a period of five years and then stored in the central archive of the plant. In parallel, all records are electronically stored in a database. Annually a back-up CD is produced and transferred to the central archive.

The verification activities performed do not give rise to particular remarks.

9.1.4 Control room

The verification team visited the Unit 1 control room. The chief supervisor informed the verification team how data from the gaseous and liquid effluents are gathered and monitored. The verification team was informed that the chemistry laboratory results on the effluent activity are presented for the approval of the chief supervisor before each liquid discharge. The results of the preliminary measurements are sealed and stored thereafter to ensure traceability.

The verification activities performed do not give rise to particular remarks.

9.1.5 Dosimetry laboratory

The verification team visited the Unit 1 dosimetry laboratory, which is responsible for all laboratory measurements of the NPP operator monitoring programme. Unit 2 will have a similar dosimetry laboratory, but this was not yet operational at the time of the verification visit.

The laboratory has in total staff of 13 persons. Six persons work per shift in both units.

Liquid effluents (LEM)

The dosimetry laboratory measures the activity of approximately 700 discharges from LEM system tanks every year. The samples are measured by gamma spectrometry and are kept for a period of one week until the data are validated and the discharge authorisation is produced by the Health Physics Technical Services..

Gaseous effluents (GEM)

The dosimetry laboratory measures the activity of the GEM system sampling filters. The particulate filters are measured by gamma spectrometry and alpha/beta-counting. The iodine filters are measured

by gamma spectrometry. The filters are kept in the laboratory archive for one year after the sampling period.

Environmental samples

The dosimetry laboratory also measures some on-site environmental samples.

Equipment

The laboratory has two HPGe gamma spectrometers (*Canberra* 20% and 30%) using *Genie 2000* analysis software. There are also two liquid scintillation counters (*TRI-CARB 3100 TR* and *TRI-CARB 2700 Tr/LL*). Alpha/beta measurements are carried out using a *Canberra* α/β-counter. All the devices were operational at the time of the verification visit.

A UPS providing 3 hours autonomy is available for each measurement system. Maintenance is provided by the equipment manufacturers based on service contracts.

Daily controls are performed (efficiency and energy) for the whole measurement chain; a complete recalibration is performed annually. Quality control logs are kept on PCs.

Calibrations are based on *Amersham* mixed-nuclide standard sources; a Eu-152 source is used for the daily controls.

The verification team was informed that in Unit 2 a new generation of *Canberra* equipment is in place already. When needed, the laboratories can provide back-up services for each other.

The analytical balances for sample preparations are calibrated twice a year by the site metrological laboratory.

The laboratory measures the TLDs for environmental monitoring on a routine basis and in the event of an emergency.

Quality assurance

The laboratory has a *Microsoft Access* sample database system. Samples receive a unique number and are labelled on the sample container (cork). One person is responsible for the sample throughout the process from sample registration to measurement and data handling.

The laboratory has a very good system of files, making it easy to consult and find data. Sample registers can also be found in notebooks along with information on the calibration and maintenance procedures, used standards and calculation of results. The procedures are clearly documented and kept available at every measurement system. A back-up data CD is created periodically.

The laboratory is designated by CNCAN for personnel dosimetry; it is in process of being designated also as testing laboratory notified for effluent monitoring. The laboratory is a member of the *PROCORAD* measurement laboratory association since 2001. It participates annually in national and international intercomparisons, e.g. the IAEA intercomparison exercise for gamma spectrometry in urine in 2000 and the *PROCORAD* intercomparisons for C-14, H-3 and gamma spectrometry since 2001. The laboratory has the status of a reference laboratory for H-3 and C-14 analysis in urine.

The verification activities performed do not give rise to particular remarks.

9.1.6 On-site environmental radioactivity monitoring

General

The verification team was informed that the on-site environmental monitoring is done by the Environmental Control Laboratory, the Dosimetry Laboratory and by the Operation Division. The internal procedures for sampling, preparation and measurements of samples are developed by each designated group. The Health Physics Technical Services elaborates the monitoring programme and its revisions and prepares reports for the authorities and the management team.

The procedures for sampling, preparation and measurement, have been developed by the laboratory staff. The laboratory is notified by CNCAN for ISO 17025 and is in the process of 'accreditation' by

the Ministry of the Environment. Work on this project has started some 2 years ago, all documents are ready, but the accreditation is under revision.

Air sampler

The verification team was informed that for iodines the measurement is performed quarterly if no discharges occur through the stack. If discharge values (based on filter and noble gas measurements) are > 5% of the weekly DEL the iodine measurement is performed weekly. For 10 years no I-131 has been detected because no fuel defects occurred.

Measuring intervals for H-3 on molecular sieve are once per month.

The verification team witnessed the change of the paper filter (performed weekly). It remarked that for iodine sampling the procedure was not available locally. For the device a service contract (48 hours) exists. The station has a UPS battery backup (2 days holding time), a cooled cabin and noise reduction. A spare (back up) station is available in the lab.

Verification does not give rise to recommendations, but the team suggests making all relevant procedures available at the working place.

Dose and dose rate measurement

The verification team was informed that several locations have long-term dose measuring devices (TLD based) in place and saw one of them. However, no automatic system covering the perimeter around the NPP is available.

The verification team recommends exploring the possibility to set up an automatic on-line dose rate monitoring system that would continuously transmit values to a central location.

Ground water

The verification team was shown the vault with the sump for seepage water, predominantly from rain, less from ground water. It observed a sampling. The bottles are marked, however without a date. The team was informed that if the measurement shows a low value the sump is drained.

Previously there had been four drains; however only one contained water, the others were dry.

Verification does not give rise to any specific recommendation, but the team suggests marking the sample bottles with date and time.

9.1.7 Off-site environmental monitoring programme

Introduction

The verification team was informed that the off-site environmental monitoring programme covered the 30 km zone plus background sites. It is managed by the NPP's Environmental Control Laboratory situated in Cernavodă town.

Air samplers

The verification team visited the site of the air sampler at the NPP's laboratory in Cernavodă town. It also visited the equipment at Seimen (located at a large abandoned milk farming site, just south of the village). The places are fenced-in to avoid vandalism and theft. They consist of the same devices as the sampling equipment on-site at the NPP. At Seimeni the team observed sample changing for filter and the molecular sieve. The location is well chosen, on a hill, with no large buildings and high trees in the immediate surroundings. The team notes that the sampling technician worked with gloves and that he kept very orderly notes.

The verification team remarks that at Seimeni several trees near the sampling device may have to be felled in the coming years to avoid influence on sampling.

Precipitation sampling

The team witnessed the precipitation sampler at the NPP's laboratory in Cernavodă town. It has a surface of 1 m². If it does not rain it is washed with distilled water.

The verification does not give rise to any remarks.

Dose and dose rate monitoring

The verification team saw one of the TLD devices of the NPP's off-site dose monitoring network (at the air sampler location at Seimeni).

It was informed that formerly a *Reuter Stokes* dose rate monitor had been available; however this device is no longer in operation. Currently it is foreseen to buy a system of automatic ambient gamma dose rate probes (in the first phase four devices, later to be extended to ten) for an area of some 10 km around the NPP with data communication to the NPP and the NPP's Environmental Control Laboratory.

The verification team encourages the plans for installing an automatic on-line ambient dose rate monitoring system in the surroundings of the NPP.

River water, sediment and soil sampling

The verification team visited the site of Danube River water sampling near Seimeni at km 293. The team was informed that Danube water is used for irrigation. On the flat ground near the river soil samples are taken.

Verification does not give rise to any specific remarks.

Milk sampling

The verification team visited the Seimeni milk farm; at the time of the visit the cows were not in the stable, they were on pasture. Milk samples are taken every week, on Wednesday at 9 a.m.

The farmer and the sampling personnel informed the team that currently no preservation of the milk samples is performed (formerly formaldehyde was added). Preservation is not anymore needed because a quick gamma spectrometric analysis is performed immediately after return to the laboratory.

Verification does not give rise to any specific remarks.

Vegetables, fruit sampling

The verification team was informed that in April and May samples of onion, salad and spinach had been taken, and in June cherries. Produce at markets is sourced locally.

Verification does not give rise to any specific remarks.

Fish sampling

The verification team was shown Lake Domneasca-Seimeni, located between Cernavodă and Seimeni, where in March and October fish samples are taken from a fish farm. Danube fish are only bought from fisherman at Cernavodă.

Verification does not give rise to any specific remarks.

9.1.8 NPP's Environmental control laboratory

General

The verification team visited the environmental control laboratory of the Cernavodă NPP, situated in Cernavodă town, at 5 km distance from the NPP.

Laboratory staff is responsible for sampling, sample preparation, measurement and transfer of data within the NPP's intranet. Data validation is performed by the head of the laboratory.

The team was informed that of the 8 persons in the lab 5 are trained for measurement, and 3 for calibration. The NPP has to ensure that technical assistance with regards to measuring techniques is available to the lab when needed.

The laboratory itself is spacious, well kept and very orderly.

At the location of the laboratory a display showing ambient dose rate in comparison to values in neighbouring villages is foreseen to be set up.

Sample registration

The verification team was informed that generally during sampling in the field a label is put on the sample container with the basic information; the sample forms themselves are filled-in in the laboratory.

After registration, the samples marked by sample code and number usually go to the gamma lab for measurement.

Sample preparation

The verification team was informed that sample containers are not reused. Food samples are dried before gamma measurement. For gross beta measurements samples are ashed and fixed on a sample tray. For C-14 determinations a special combustion procedure (Canadian method) is used to prepare the sample for liquid scintillation counting. For H-3 determination, azeotropic distillation on fresh samples is performed.

Measuring

Gamma spectrometry

The laboratory has two *Canberra* HPGe detectors of 20% rel. eff. and 1.8 keV FWHM; it uses 19" amplifiers (the data sheet and all manuals are available on site). Data acquisition and analysis is done on a PC using *Canberra APEX* software. No backup PC is available.

The verification team was informed that *Canberra Genie Quality Assurance* is used. In case of problems the measurement would be redone and/or colleagues from the NPP or *Canberra* (service contract) would be contacted.

For milk and water samples 4 l Marinelli beakers and for vegetation, soil and sediment samples 0.5 l Marinelli beakers are calibrated. Two other calibrated geometries are available as well (for air filters and charcoal samples).

For calibration sources every year a mixed radionuclide source (*Amersham QCY44* with *UKAS* certification) is bought. The standards (liquid for Marinelli, solid for air filters and charcoal cartridge geometry) are prepared by the chemistry unit of the NPP. Calibration is done according to the internal procedures IDP-RP-144 and -145.

Efficiency calibrations are now performed once per year (formerly once per year only an efficiency calibration validation was necessary).

The lab performs daily energy checks with Eu-152. Peak FWHM checks and optimisations if deemed useful are done daily, according to the internal procedure IDP-RP-151. Background is checked weekly (every Friday) according to the internal procedure IDP-RP-150.

For gamma spectrometry every year a mixed radionuclide source is bought from *Amersham*. The chemistry unit prepares the standards.

The lab is connected to the NPP intranet via the local network. Gamma spectra are stored on the local hard disk (no connection to network) and are archived once per year on CD-ROM.

Alpha and Beta measurements

The laboratory performs H-3, C-14 and gross beta determinations. Determination of organically bound tritium (OBT) could be done but this would be seen rather as supplementary scientific research. For C-14 the laboratory is 'reference laboratory'.

The laboratory is equipped with a *Canberra* (*Tennelec*) low level alpha/beta counter model *LB-4110* with 8 detectors (two trays with four positions each), a result calculation system and the QM option built in. The counting gas (Argon-Methane) is supplied by *Linde*.

Calibration is done according to the internal procedure IDP-RP-149 using standard sources of Sr/Y-90 for beta calibration and daily QA verification. For alpha calibration and daily QA verification an Am-241 source is used. For the alpha and beta detector efficiency calibration the internal procedure IDP-RP-153 requires a daily check. The system background is checked weekly according to the internal procedure IDP-RP-152.

The laboratory also has an Ultra Low Level liquid scintillation counter *Wallac 1220 Quantulus* with built-in calculation system. The device is used for C-14 and H-3 determinations. Calibration is done according to the internal procedures IDP-RP-147 and -148. For calibration certified unquenched H-3, C-14 and background standards are used. For counting efficiency and system background the internal procedure IDP-RP-154 requires a weekly check.

The verification team was informed that background water for H-3 measurements is bought (commercial, certified); formerly the laboratory used water from a deep well near Constanța (recommended by the authority). Theoretically the lab could use water from a deep well owned by the NPP (500 and 700 m depth) which has a very low H-3 content.

For H-3 and C-14 calibration purposes the laboratory has certified standards.

TLD

The verification team was informed that the laboratory handles 916 TLDs per year.

QA/QM, Intercomparison exercises

The verification team was shown a copy of the CNCAN notification for ISO 17025.

During the check by the team all procedure documents asked for were promptly available on site; staff members knew all these procedures in detail (including those concerning sampling).

Due to problems with temperature in the lab (electronic stability) with regard to gamma, beta and LSC measurements every morning check sources have to be used.

The laboratory has a general QM log and logs for each device (including all relevant information)

Since 2001 the Environmental Control Laboratory participated in intercomparison exercises (organized by the PROCORAD Association from France and since 2006 in proficiency tests organized within the ALMERA Network of IAEA). The laboratory acts as a reference lab for C-14 analysis.

Tracing of a historical sample

The verification team performed a tracing of an air filter from the first week of May 2004. Since the *Canberra APEX* system was installed only in 2006 the electronic version (produced by *Genie PC – OS/2*) was already on an archive disk in the NPP. The verification team checked the printed version and found no discrepancies.

In addition, the team performed a tracing of an air filter from May 2005 and a Eu-152 energy check spectrum and found the results in order.

Archiving

All samples are stored for one year after the report to the regulator in the laboratory and are then transferred to Unit 1, according to the power plant procedures, the quality assurance and the control procedures in place.

All measurement results (measured values and detection limits) are kept in the lab for 3 years; then they are recorded in the environmental data base according to the MM-05/BSI 96600 procedure and archived yearly on magnetic support.

Reporting

All measurement results are printed and kept on paper support as data reports with recording sheet. The measurement results are also recorded in the environmental data base.

The measurement results are reported to CNCAN, to the Ministry of Environment and to the sanitary authorities by the Health Physics Technical Services, which is responsible for independent assessment of environmental data, reports and evaluation.

The verification team was shown that all information is available on paper and in a data base. It was told that in case of abnormal results the possible reasons are investigated and checks on samples of several different media are performed. NPP emergency staff is contacted. If deemed necessary additional samples are taken. However, this seems not to be fixed in the procedures.

Verification of the NPP's Environmental Control Laboratory does not give rise to any specific remarks.

9.2 CERNAVODĂ NPP – INDEPENDENT CONTROL BY THE REGULATOR

9.2.1 CNCAN environmental laboratory in Afumați

General

The verification team visited the CNCAN environmental laboratory in Afumați, close to Bucharest. There are 15 persons working in the extended emergency organisation in the cases of a possible radiological accidents but only 5 persons (plus one suspended position) are working in the Section for Radiation Emergencies, performing routine activities in CNCAN's emergency response centre. From these five persons, three are directly involved in performing environmental radioactivity measurements.

The verification team recommends ensuring that enough qualified personnel is available in CNCAN's Section for Radiation Emergencies, in order to be able to manage the specific radioactivity analysis on the environmental samples, measurements necessary to a good control of the NPP.

Sampling and sample preparation

Several hundred samples are received and analysed by the laboratory for tritium activity each year. Less than one hundred samples are analysed for gamma activity. The CNCAN laboratory is focused on analysis of samples taken from the Cernavodă area.

Incoming samples are split and registered separately according to the planned measurements: one sample for LSC analysis and one for gamma spectrometric analysis. CNCAN laboratory has a drying cabinet and two furnaces for sample preparation. All premises were clean and in good order. The same personnel perform the sample registration and preparation for both types of analysis (beta measurements and gamma spectrometry).

The team verified the sample preparation for tritium analysis (water, air, milk, grass, vegetables, fruits, soil). Sample labels are attached to the cap of the LSC measurement bottle. This practise may give rise to occasional errors if caps are switched for any reason.

Sampling and measurement data are recorded in the laboratory logbook and the measurement results on a PC. The verification team was told that CNCAN has a central data server (obtained from a PHARE project) and it is dedicated to all activities in the Emergency Response Centre. The server was installed at the beginning of 2007, so it was already in place during the verification visit, however, not operational yet. The results of measurements were not kept on the server at that time, but on a single PC. The registration of samples is kept in hard copy and not in an electronic database.

Analytical scales used by CNCAN's laboratory are periodically calibrated by the laboratory personnel.

The verification gives no rise to recommendations.

Radiation measurement equipment

The laboratory performs beta and gamma spectrometry on air, soil, precipitation, aerosol, vegetation and water samples and also on milk, vegetables and fruit samples.

The laboratory has a PHARE-funded *Perkin-Elmer Tri-Carb 3100TR* LSC-counter. Two persons have been trained on the device. Calibration is performed with standards supplied by the instrument manufacturer.

The laboratory has also an old *Packard 1905 AB/LA* Liquid Scintillation Counter (LSC). In this system the counting efficiency and background count rate are determined for each batch of samples using tritium standards and background samples (H-3 and C-14 calibration standards).

The laboratory has an old HPGe-detector (*Canberra*, 30% efficiency) for gamma measurements, but at the moment the laboratory was not able to perform gamma spectroscopy due to liquid nitrogen supply problems.

The laboratory has received a new HPGe detector of relative efficiency of 40%. The device is connected to a *Canberra* multichannel analyser *Inspector 2000* with *GENIE 2000* and *ISOCS* analysis software. *ISOCS* software facilitates also Monte Carlo based efficiency calibrations.

The laboratory does not have any routine for regular control of the energy, resolution and efficiency calibrations of the HPGe detectors in order to ensure stability of the systems. The calibration standards in use are *Amersham* Marinelli and Petri sources from 1996. CNCAN's staff emphasized the need to have new sources.

> *The verification team advises CNCAN to ensure regular liquid nitrogen supply to the laboratory with appropriate back-up arrangements.*
>
> *The verification team advises CNCAN to purchase new calibration sources and establish a regular control programme for HPGe detector energy, peak width and efficiency calibrations.*

Mobile systems

The laboratory mobile team is in charge of field dosimetry and sampling in routine and emergency situations. The laboratory mobile team is composed of two persons from the total of five operating in routine conditions in CNCAN's Emergency Response Centre; in emergency situations they are supported by other persons belonging to CNCAN staff. The laboratory has a PHARE-funded *Nissan Pathfinder* monitoring vehicle equipped with an in-situ gamma spectrometer (*Canberra*) and portable dose rate meters (*RADIAGEM 2000*, *Automess*, *Eberline*). There is a plan to install a new mobile NaI(Tl) detector with GPRS data transfer. For the moment only dose rate values can be gathered (no spectra). The laboratory personnel have so far received no training for mobile measurements.

> *The verification team recommends CNCAN to carry out training on mobile measurements for a sufficient number of staff members.*

Sample storage

CNCAN has a storage room where samples can be kept for up to 3 years.

> *The verification gives no rise to recommendations. The verification team suggests CNCAN to define a formal sample archiving guideline as part of its quality manual.*

Reporting

All data are reported and stored at CNCAN.

The results of the CNCAN radioactivity monitoring programme are included in the annual CNCAN report and periodically reported to the Government of Romania. The results are systematically compared with the ones reported by the Cernavodă NPP. The results are used to determine the additional radiation exposure of the population due to the operation of the NPP, especially in relation to tritium emissions.

> *The verification gives no rise to recommendations.*

Quality assurance

CNCAN's laboratory is not accredited, but the team was informed that it is in process of accreditation. The verification team took note of the CNCAN laboratory and emergency group quality manual dating from 2005.

The laboratory has participated between 1996 and 1997 in intercomparison exercises with Cernavodă NPP on C-14 measurements in vegetable and fruit samples.
In 1996 and 1997 it participated in intercomparisons with the Institute for Meteorology and Hydrology on tritium measurements in ground water samples.
For gamma spectrometry the laboratory has participated in past IAEA intercomparisons on environmental sample measurement.
The laboratory has organised several national intercomparisons within NERSN's laboratory network in the 1980's and 90's. Between 1998 and 2001, the laboratory was involved in coordinating the radioactivity stations of the National Environmental Radioactivity Surveillance Network (NERSN), and intercomparison exercises were organized accordingly by CNCAN's laboratory.

The verification team supports the intercomparison activity and CNCAN's work towards accreditation according to ISO 17025 for all analytical tasks.

9.2.2 LEPA Constanța - SSRM Cernavodă

General

NERSN's local environmental monitoring laboratory at Cernavodă is a type '24 hours' laboratory that strictly follows its daily programme (normal for national monitoring tasks and special). Currently 6 persons are employed. At the time of the visit 1 employee was pregnant, a physicist whose main task was to perform in-situ tests for the new mobile equipment. The labs special programme includes analysis respectively preparation of milk from small farms at Faclia (2 cows) and Cernavodă (10 cows) and of a large farm (some 100 cows). Sub-samples of ½ litre are sent to Constanța for gamma spectrometry. No H-3 determinations are made in milk samples. This formerly was done by NEPA in Bucharest but their oxidizer broke down.

Air samples are measured for gross beta activity at location; for gamma spectrometric analysis they are transported to SSRM Constanța, then (together with other samples) to the NEPA laboratory in Bucharest.

The verification team was informed about original intentions to operate a high resolution gamma spectrometry system in this laboratory. Currently all samples that have to undergo gamma spectrometric analysis are sent to SSRM Constanța.

The laboratory at Cernavodă has an in-situ gamma spectrometer with HPGe detector based devices in a 4x4 car coming from the PHARE programme. (A separate car is available for transports.) The verification team was informed that setting up of procedures for using the car based systems has been delayed until the new PHARE project is running; meanwhile tests are performed with the equipment. These are overseen by NEPA Bucharest.

Sampling devices

The verification team saw the air sampling device used within the '24 hour' laboratory system. The laboratory uses the new sampler (type *VOPV-10*) because the old one broke down. Since filters from the new sampler do not fit in the 'old' measuring device, the new beta measuring device (*Thermo Electron FHT100*) has to be used.

For tritium in air the laboratory has a new HT/HTO sampler (*TASC* – tritium in air sample collector; *Overhoff Technology Corporation*; Milford, Ohio, USA).

Sample registration

The samples come to the laboratory together with a completed sampling sheet (sample type; sample location; name of sampling person; date and time of sampling; sample "quantity" etc.) and are registered in the sample register receiving a unique number. The sample recording sheet contains all

the information regarding the collection coordinates, which determinations have to be performed, and sample preparation and measurement details. All data are kept on paper.

Sample preparation

With regard to surface water, drinking water, ground water and precipitation the same procedures as at SSRM Călăraşi are used.

For beta determination in water samples IR evaporation is performed. The bowl is scratched out with a razor blade (the verification team was informed that there has never been an accident). The sample description is kept on small paper notes close to or on the ceramic evaporation bowl. The procedure is well described and available at the site.

For H-3 in water samples a new distillation column has been installed. Volumes of 200 ml are distilled and collected in a separate flask. From that the sample, 10 ml for measurements is pipetted in the LSC vials. Another 20 ml are stored for verification measurements.

Measuring devices

LSC

A new *Perkin Elmer TriCarb 2900 TR* LSC device with *QuantaSmart* software has been set up in an air conditioned room. The inbuilt QM feature is used. The current task is to compare results with those from NEPA Bucharest. The verification team was told that staff expects routine operation in two months (however a routine programme doesn't seem to exist).

A UPS for the device is available.

All manuals are at the site.

For background determination, the lab uses the same "deep-well" water as NEPA Bucharest.

Mobile unit

The verification team was shown the mobile unit that has been acquired within a PHARE programme (altogether 3 cars were bought from *Canberra Central Europe*; they were set up in and transported from Austria).

The basis is a *Landrover Defender* 4x4 vehicle. The car is currently being licensed (it still has a Bucharest license plate).

It is equipped with front and rear winches; radiation measurement devices in two *Zarges* aluminium cases. Electricity is supplied by a fuel powered *Endress ESE 30 BS* electricity generator with a *Honda GC 160* motor. The car contains a *Thermo Electron* plastic scintillator as detector (in aluminium case), a GPS for navigation, an air sampling pump (*VIEW*) and a *Canberra Inspector 2000* device with notebook for program and data storage. *Genie 2000* plus *ISOCS* software is installed. A UPS guarantees electric power. A tripod serves for detector mounting.

A service contract for the mobile measuring systems is available.

> *The verification team recommends setting up a routine programme for H-3 measurements in this laboratory, at Cernavodă, close to the NPP. It also recommends reconsidering to install a high resolution gamma spectrometry system in this laboratory with a view to avoid time delays due to transporting samples to SSRM Constanța. The use uf a suitable Laboratory Information Management System should be considered.*

9.2.3 LEPA Constanța - SSRM Constanța

The SSRM environmental laboratory participates both, in the national monitoring (verification see chapter 9.4.6, including an automatic station (verification see chapter 9.3.4) and in the NPP related monitoring. A detailed overview of the laboratory verification is given in chapter 9.4.6.

9.3 AMBIENT GAMMA DOSE RATE MONITORING NETWORK

The verification team visited the following gamma dose rate monitoring stations (the verification of the associated laboratories is given in Chapter 9.4. below):

9.3.1 At the NEPA environmental laboratory in Bucharest

The verification team was informed that due to reconstruction work some changes with regard to the siting of equipment had to be made.

The gamma dose rate detector belonging to the automatic ambient dose rate monitoring system around Cernavodă and Kozloduy influence area, has been installed in the court yard ('garden') with the corresponding electronic device still being mounted on the roof of the two storey building that houses NEPA's radiological laboratory in Bucharest. The system was implemented in 2004 and consists of probes produced by the *Institut Nationale des Radioélements* (IRE, Fleurus, Belgium) and a central station also produced by IRE (managed by a Romanian subcontractor: *Rokura*).

Data transmission from all 49 stations is currently performed by satellite; however for cost reasons NEPA wants to switch to GPRS. Three automatic stations have GPRS transmission (in test). Data are transmitted to servers; the devices have backups and are firewall protected.

A maintenance contract with a Romanian firm exists.

The system produces status messages in pop-up form, e.g. in case of abnormalities. The verification team was informed that in such cases a call is received.

The system also has presentations in pre-defined layout of radiation alarms (fixed levels), maps (with 3x zoom, but not a real Geographic Information System – GIS), tables, graphical options, last value display, status information, etc..

Under normal conditions the stations send a data package with 24 hourly average values daily. In alarm mode the transmission is changed to 5 minutes.

The data centre can directly access the stations; configuration of the devices (password protected) is possible from the centre.

For validation the data are transferred to a maintenance laptop where they are prepared for validation using proprietary software. After validation data are re-imported to the system.

Validated data are sent to 8 labs, however not yet to EURDEP. Data transmission to EURDEP is close to finalisation.

> *The verification team encourages all efforts to transmit data from this system to EURDEP.*

'New' system

Within a PHARE project 39 stations with GSM/GPRS main transmission and satellite transmission were set up.

Currently at NEPA Bucharest the data receiving and presentation facilities are in the installation phase. During the visit a technician from the German producer was working on it. The verification team was told that the system will be finished 'very soon'.

The detectors for this system are from *RADOS Technology*, Italy, the system itself is from *UIT GmbH*, Dresden, Germany.

Currently some devices have problems, e.g. with communication. This will be fixed under warranty.

Two mountain stations at around 2000 m altitude: Babele (Bucegi Massive) in the southern Carpathians and Toaca (Ceahlău Massive) in the eastern Carpathians are foreseen but have not yet been installed (delay due to weather conditions; the locations can only be reached in July by foot or helicopter).[7]

[7] The device has been installed in the meantime.

Electric power for each station comes from the grid plus battery and a solar panel as backup. All stations have a similar layout. Location identification is based on the geographical coordinates.

Measuring data are also displayed locally on the equipment, presented in μSv/h.

The system also includes meteorological data from a meteorological mast.

Data transmission by GPRS is at 5 minutes intervals in binary format.

The verification team was given a short presentation of the display software.

Devices in yard ('garden')

The verification team saw the 2 dose rate detectors of the 'NPP Cernavodă and Kosloduy's system, set up in the yard approx. 10 m from buildings, in a fenced in (but not locked) area. Formerly the detectors were installed on a platform on the roof of the building. The verification team was informed that three weeks before the visit the detectors had to be moved because of plans to add an additional floor on the building. However, these plans apparently were cancelled. NEPA may move the device back if possible.

The verification team saw the meteo mast of the new system in the yard.

The verification team recommends completing and setting-up the 'new' system in an efficient and speedy way.

9.3.2 At SSRM Călăraşi

The verification team visited the automatic monitoring station at Calarasi, which is part of the local NERSN laboratory (an '11 hour' laboratory). The gamma dose rate detector belonging to the EWS around Cernavodă is mounted in the back yard (garden) some 220 cm above ground. The team was told that the former NEPA superior had selected that measuring height, the new responsible persons now want to lower it.

The GM tube of the 'old' system is mounted ca. 100 cm above ground.

Data transmission for the automatic station is done on-line (once per day sending hourly average data) and for the 'old' system by telephone (the maximum and average value plus the value from 8 o'clock are communicated).

The verification team advises finding a solution for mounting all dose rate detectors 1 m above ground.

9.3.3 At SSRM Slobozia

The laboratory in Slobozia has a PHARE-funded automatic monitoring station (Cernavodă related early warning system) situated in the laboratory building backyard, with dose rate and rain detector. The verification team notes that the place is well chosen, reasonably far from significant obstacles; however mounting of the gamma detector is too high.

The verification team advises finding a solution for mounting the gamma dose rate detector 1 m above ground.

9.3.4 At SSRM Constanța

SSRM Constanța is located within the premises of the Constanța meteorological station. The verification team was told that the automatic gamma dose rate monitoring system (an *IRE* device from the 'Cernavodă - Kosloduy" system) is still mounted on the roof of the LEPA building in downtown Constanța. The equipment will be moved to the meteorological platform in the garden/back yard close to the building where the laboratory currently is situated.

There is daily registration and 'manual' data transmission of values from the 'old' system (*IFIN-HH* GM tubes) to NRL, Bucharest. The PC with data transmission software (e-mail or print/fax) is already located in the new building.

The verification team encourages quickly transferring all necessary devices from the 'old' to the 'new' location.

9.3.5 At SSRM Tulcea

The verification team saw the 'new' system dose rate detector with solar panel. The detector is mounted 1 m above ground; however slightly shielded by the solar panel and electronics cabinet.

The verification team advises finding a solution for mounting the dose rate detector in a position without obstacles.

9.4 NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING LABORATORIES

9.4.1 Introduction

In accordance with the agreed verification programme, the verification team visited NERSN's radiological laboratories in Bucharest, Afumați, Cernavodă, Călăraşi, Slobozia.

The samples collected in different SSRM districts (radioactivity laboratories) within the country partly stay in the laboratories for measurements and partly go to NEPA's main laboratory in Bucharest, NRL, or other specialised NERSN laboratories for specific analysis.

9.4.2 NEPA central radiological laboratory at Bucharest

General

The verification team visited the central NEPA laboratory that had recently moved to the first floor of the building and at the time of the visit was in the process of renovation. Not all the measuring devices were functioning at the time of the visit.

The verification team was told that after reorganisation the 'new' ministry (Environment and Sustainable Development) seems to have other financial priorities. Thus, NEPA does not know when the renovation work will be finished. The laboratory had to stop all measurements because of the renovation.

The team noted that seven persons are employed in the laboratory. Laboratory staff is young, and has not yet developed large experience; old staff (from before the reorganisation) has left for reasons of low salary (this includes the gamma spectrometry experts)

The verification team was told that the laboratories belonging to the Ministry of the Environment generally have different programmes but the same equipment and procedures; NEPA Bucharest coordinates the environmental monitoring programmes around the NPP.

For the verification results with regard to the automatic network see chapter 9.3.1.

Basically, the institute was established in 1962 by the National Institute of Meteorology and Hydrology (INMH). The documents from before Chernobyl were lost. Presently, half of the local NERSN stations are still operating at the premises of INMH stations. For transparency reasons this service is paid for although both institutions belong to the same ministry.

NEPA received funds to buy new equipment through a PHARE project. For all NEPA laboratories together, the new equipment comprised the following:
- 9 automatic meteorological stations
- 49 rain sensors
- 39 automatic dose rate monitoring stations with real time transmission of data
- 5 automatic water radioactivity monitoring systems with early warning function
- 1 network coordination center for NRL

The provider of the devices for the automatic system was *UIT GmbH Dresden*.

Through the same PHARE project NEPA received also:

- 18 gross alpha/beta low background counting systems
- 18 high volume aerosols samplers
- 1 high resolution gamma spectrometry network
- 1 ultra low-background high resolution gamma spectrometry system
- 1 gamma spectrometry system (well detector)
- 1 ultra low level liquid scintillation analyzer
- 1 liquid scintillation analyzer
- 7 radon monitoring devices
- 9 portable monitoring kits
- 1 aerial gamma spectrometry system
- 4 atmospheric tritium samplers
- 3 atmospheric C-14 samplers
- 3 mobile laboratories

The provider of the laboratory equipment was *Canberra Packard Central Europe GmbH.*

In the near future, via another PHARE project, NEPA hopes to receive the appropriate training to handle the received devices.

Sample preparation

The verification team was told that due to the renovation work, currently no sample preparation can be performed.

Gamma spectrometry room

The verification team was shown the gamma spectrometry systems of the lab, all from *Canberra* with broad energy germanium detectors, *DSA 1000* plus PC, digital spectrum acquisition and analyzer (*Genie 2000*), cylindrical lead shielding. The team was informed that the counting times used depend on the type of sample. The Canberra system *ISOCS* is used for calibration and the system *LABSOCS* for QA/QC.

Due to renovation work at the laboratory, the devices were not in operation during the visit and no procedure was found.

NEPA has a service contract with *Canberra*. With regard to LN_2 supply a delivery contract (on call) has been established.

The team was told that measurement results of gamma spectrometric analyses done in various other district laboratories (in total six devices were received within PHARE) are transmitted to NEPA Bucharest and are stored using a 'logical' identifier.

Alpha/Beta measurement

The verification team noted the existence of 'old' equipment from the 90's – e.g. an old *TriCarb* LSC device – and from the 80's (gross beta measurement device).

The verification team noted the presence of a *Quantulus* ultra low level Liquid Scintillation Counter (received within the PHARE project) which at the moment of the visit was not yet used routinely. H-3 and C-14 samples cannot yet be prepared (within the PHARE project the wrong reagents were supplied and have to be replaced).

An alpha spectrometer, type *Ortec*, received from IAEA, at the time of the visit was also not operating.

In the laboratory, a *Packard TriCarb 2770TR/SL* (from IAEA) was operational for analysis of H-3 in precipitation and surface water including samples from Cernavodă. The analysis data are available on PC and on paper; the results are also stored in a *MS Access* data base.

The team was informed that both, for the liquid scintillation analysers for tritium measurement and for the gross alpha/beta low background counting system for gross alpha and total beta measurements the counting times used depend on the type of sample.

Sources

NEPA has received an open Sr-90 source. It also received a sealed Eu-152 standard contained in a measuring device.

Source certificates were available from the Czech Metrological Institute at Prague and PTB.

The verification team was told that CNCAN will give to NEPA the adequate license for using the three radioactive sources received via a PHARE project.

Quality assurance, archiving

The radiation laboratory is not accredited according to ISO 17025 or certified according to ISO 9001. The laboratory received construction authorisation from CNCAN in 2006 but is not yet 'notified' by CNCAN.

The verification team was told that calibration and maintenance procedures are in place. A QM manual exists; the procedure part of it contains a set of procedures for normal and emergency tasks, including all algorithms to be used. The team did not get information about the source of the algorithms (originally supplied by CNCAN). Procedures ask for daily checks and yearly calibrations. Result calculations are built-in in the measuring devices.

Logbooks for measurements exist, however, due to moving, their application has just started.

Scales are calibrated once per year (legal obligation) by an official institute (Romanian Bureau of Legal Metrology, BRML).

All the measurements reported daily by the NERSN are automatically collected, converted into a special data sheet format, verified and validated. The result sheets are printed out and signed. A global report is then sent to the national decision bodies and to EC through the EURDEP platform.

All measurement results are printed and kept on paper support as data reports together with the recording sheet. All measurements are recorded in the laboratory data base and archived yearly on optical support.

The team was informed that the laboratory has problems with 'Trojans' in the IT tools.

Data collection, reporting

Data from the laboratories all have the same format, following a standard programme. Transmission of data concerning sampling, analysis, procedures, etc. is done via e-mail or fax.

The team was shown the equipment for the network tasks, currently undergoing acceptance tests by the German supplier. On one server the data for 39 gamma dose rate stations are contained, on one screen the results of the 5 water stations were shown. Data update is every 5 seconds.

The measurement results are checked with a special verification programme and printed. Averages for the stations near Cernavodă and Kosloduy complemented by an evaluation by the duty officer are reported in graphic form and tables to the national decision-making body (inter-ministerial committee including CNCAN; defence, administration and environment ministry). All data are transmitted to the EC/JRC Ispra.

The verification team was told that currently data transmission for gamma dose rate, total beta in air, and total beta in water to EURDEP is daily, however currently a programme is under development which would allow more frequent data transmissions.

For reporting of 'delayed' data (i.e. data from laboratory measurements) an *EXCEL* programme made at NEPA is used. This programme, which is constantly improved, is also available in the local laboratories; it also includes meteorological data and graphical overviews.

Monthly internal reports are produced (signed by the duty officer) regarding the data transmission status etc. (e.g. e-mail problems, power cuts). An annual overall report that includes gamma spectroscopic data received by e-mail or on CD-ROM is produced as part of a bigger report containing also other (non-radioactivity) areas. This report is also sent to the European Environment Agency (EEA) in Copenhagen.

Mobile systems

NEPA has a mobile laboratory system received within the PHARE project, equipped with a *Land Rover Defender* 4x4 all terrain vehicle, and a fixed system for plume tracking (in-situ gamma spectrometry system with coaxial germanium detector; portable high volume aerosol sampler type *VOPV-12*, model *K0215-04*, with an air flow of 12 m^3/h; autonomous installation for external decontamination; hand water pump; water tank of 2500 l; portable meteorological station; and GPS instrumentation). The device was not present locally and thus not shown to the verification team.

NEPA also has equipment for aerial use by helicopter (also from the PHARE project): a NaI(Tl) detector (*Canberra*); a *Thermo Electron ESM FH40G* device; GPS; altimeter for helicopter. NEPA rented a helicopter for testing the devices. The verification team did not have the opportunity to see this equipment.

NEPA is currently trying to set up collaboration with the responsible ministry with regard to emergencies. An exercise at Kozloduy should be used for testing the car and the helicopter based systems.

The verification team strongly recommends getting the laboratory fully operational as quickly as possible. This includes fixing the laboratory rooms and preparing all necessary procedures. For improving data safety the installation of a firewall system should be considered.

Additionally, the verification team supports all efforts to receive accreditation according to ISO 17025 to the largest extent possible.

9.4.3 NERSN laboratory at Afumați -Bucharest

SSRM Bucharest is situated in Afumați, in the same premises as CNCAN's laboratory, CRL, that does work related to the regulatory control of nuclear facilities and their environment. (The verification team visited both institutions.)

Each month all environmental samples, including drinking water and air filters, are sent to the regional SSRM laboratory in Constanța for gamma spectrometric analysis. Results of beta measurement are sent on a monthly basis in *Excel* format to NRL, which is in charge of sending data to the REM system at JRC Ispra.

Sample registration and preparation

Before measurement, the samples are prepared in three separate laboratories. In one chemical laboratory it was planned to prepare the samples for gamma spectrometry. At the time of the visit, the laboratory was not operational due to some old, partly broken hoods needing to be fixed. In the second laboratory, the distillation system for liquid scintillation counting was also not operational. The team noted the existence of a sample oxidizer, *Packard 307*, from 1998, also not yet installed due to the construction of the new hood. In the chemistry laboratory water and soil sample preparation (ashing, evaporation and drying) is performed.

The team acknowledged the sampling procedures and forms. Sample registration is done on paper giving a code to samples; the sample register contains signatures.

The verification team was told that SSRM Bucharest has all the records for the calibrations since 1986, however during the verification visit they were not found at the working place.

The verification team advises SSRM Bucharest to make available at the working place the calibration records for all the analytical scales in the laboratory as part of the laboratory's quality assurance procedures.

Air sampling and measurement

The verification team was shown a low-volume air sampler ('old' type) behind the CNCAN/NEPA building, which functions on the basis of 4 cycles a day (5 hours air sampling and one hour break) at a flow rate of 6 m^3/h. The sampler is equipped with a flowmeter, but there is no regular calibration procedure for the meter. The filters (type *Gallus 2000*) are changed on a daily basis.

The verification team was informed that one of the 'new' air monitoring devices has been delivered to SSRM Bucharest, Afumați. However, since a common approach for all NERSN SSRM locations with this equipment is awaited, the laboratory still uses the 'old' system.

Soil and sediment sampling

The verification team was informed that soil from the yard and sediments from a river nearby are sampled weekly for beta determination and annually for gamma spectrometry (usually in July).

Precipitation (Dry/Wet deposition) sampling

The verification team was shown the deposition sampler behind the laboratory building. The deposition is collected every day; it consists of precipitation water on rainy days and distilled rinsing water during dry periods. The collector has approximately 1 m diameter. No heating device is needed for melting during the cold season. The methodology of total beta measurements is based on the internal laboratory procedures.

Ground water sampling

The verification team was informed about the procedures to be used in this regard.

Surface water sampling

The verification team was informed about the procedures to be used in this regard.

Monitoring of vegetation

The verification team was told that once a week, between 1st of April and 31st of October one square meter of grass is collected, dried and measured locally for total beta after 5 days for 3000 seconds.

Equipment

Beta activity measurements are carried out with an old *NE-ST6* gross-beta measurements system. The system is able to measure only one sample at the time; data is kept on paper. The verification team was informed that a new beta measuring system has already been purchased by NEPA and it will soon be operational. The system has received the metrological certification form the Romanian authorised body, but it is still not in use due to some deficiencies in the software.

> *The verification gives no rise to recommendations, but the team suggests developing a regular calibration procedure for the air flow meter of the aerosol sampler in case this device will also be used in the future.*

9.4.4 NERSN laboratory in Călăraşi

General

The verification team visited the measuring and monitoring station in Călăraşi, situated in the premises of the Local Environmental Protection Agency.

Verification tasks with regard to the automatic dose rate monitoring equipment are explained in chapter 9.3.2.

From a staff of around 34, only 2 persons are available for radiological sampling and measurement tasks. The whole agency employs no physicist. The team was told that in case of problems one would be needed. Currently such a person would have to come from Bucharest or Constanța; in case of an emergency this is seen as doubtful.

The laboratory operates in the '11-hour-programme' mode. It has the normal (standard) programme based on the ministerial order and special programmes which are updated once per year (including weekly milk samples).

Backyard/garden

The verification team visited the backyard which houses monitoring equipment and sampling devices, as well as allowing for sampling some agricultural produce, soil and vegetation. For aerosols a small,

old sampler is available (Romanian product) with timer for sampling. The team was informed that the laboratory will switch to the new system (*VF VOPV-10*, with battery backup) when in all stations of the system the new measuring devices are ready. The old measuring device cannot hold the new filters since they have a larger diameter.

The team verified the solar battery backup available for the automatic ambient dose rate monitoring system.

Soil samples are taken at a location which since more than 10 years has not been cultivated. A volume of 10x10x5 cm is taken with a shovel. Roots are removed in the laboratory. The sample is dried under a lamp then sieved with a 2 mm device.

Vegetation samples are cut 1-2 cm above soil. Once per week beta measurements are performed, once per year gamma spectrometry, for which 1 m^2 is prepared and sent to SSRM Constanța.

The team was told that potable water is taken once per month for gamma analysis; surface water is taken from a nearby arm of the Danube. Groundwater is taken nearby at a depth of 14 m. The laboratory also takes aquatic vegetables.

Wet and dry deposition samples are taken every day; 2 collectors are available (other stations only have one). They are standardized to 0.3 m^2 surface and have a bucket to catch the liquid. In case of rain 250 ml of the sample are used for H-3 determination with higher priority; the rest of the sample is evaporated and gross beta activity is measured. If no rain occurred on that day the device is rinsed with 1 l of distilled water and no sample is reserved for H-3 analysis.

Food samples from the garden include grape, walnut, cucumber and cherries. Milk (for gamma and LSC measurement) comes from a local farm. The laboratory also collects and measures fish samples.

Sample preparation

The team visited the sample preparation room and observed a sample that underwent evaporation to dryness (under light). After cool-off the respective label is placed on the sample bowl and a razor blade is used to remove the sample from the bowl; the razor blade is then cleaned for re-use. The team was informed that the laboratory has never had an accident with this method and saw the staff being very efficient in removing the dried sample.

'11-hour' programme

The verification team was given an explanation of the '11 hour' programme.

First staff turns on the measuring equipment for stabilisation. Then a background measurement is performed followed by aerosol measurements (sampling at 02:00 to 07:00 or 03:00 to 08:00 depending on winter/summer time schedule). All data collected the previous day are then sent to Bucharest. Next the deposition sample is collected, as well as other waters, followed by sample evaporation. Then the strontium calibration source is measured, followed by the 2nd background and the 20 hr delayed measurement of the first filter of the day before. At 10:00 the filter from 13:00 of the day before is measured (i.e. the 20 hr delay measurement of the second filter).

A printed version of the programme is attached to the wall (with all the exact times). In case both persons usually performing these tasks are sick, a 3rd one is trained as well (also knowing the procedure by heart).

For result calculations a calculator is used. Then the data are transferred to an archive, the calculations are checked on a PC. An archive exists for measurements from 1990 onwards. Data are stored on PC and CD-ROM (Excel format). The team was told that NEPA wants to change to a real database within the 2nd PHARE project, including the according working procedures and an ISO 17025 accreditation; this PHARE project was started in 2004/5; terms of reference were posted.

Staff knows the programme and the procedures very well; they work with an alarm clock to remind them when tasks should be carried out.

Counting and data transmission room

The verification team noted several UPS (power supply for 1/2 hr to 5-6 hr), guaranteeing electric power for each PC; the devices were supplied within the PHARE project.

The team was shown the available measuring devices: old (*IMH CMR ß03*) and new (built in detector tube with *Thermo Electron Inc. FHT1100* digital ratemeter for beta, external detector tube with *Silena EX AM06* counter for alpha measurements). Both, the old and the new device are operative. Complete switching to the new system is foreseen when all problems are settled. Since the air filters from the new sampler do not fit into the old measurement device they have to be cut accordingly for measurement there.

Measurements of local samples are for gross beta and gross alpha activity (all other analysis tasks are done at other locations, e.g. for gamma spectrometry samples are sent to the NEPA laboratory in Constanța).

For air filters 'immediate' (i.e. measurement starts 3 minutes after end of sampling), '20 hour delay', and '5 day delay' measurement are performed in the laboratory.

The team was given a demonstration of gross beta measurement and noted that background: measurement was done with the sample holder but without (empty) planchette.

For equipment handling the relevant manual is in place, but is not needed by the personnel.

Calibration sources are kept locked. For the use of the scales instructions are in place. A calibration weight of 200 g is available (from *Canberra*, received within the PHARE project); after 1 year the calibration will have to be repeated by an official service.

The verification team suggests exploring the possibility of employing a knowledgable physicist for tasks associated with the whole local environmental protection agency.

With regard to the preparation of evaporated samples the team advises switching to a method for removing residue that avoids the risk of cutting accidents with razor blades.

With regard to analysis of samples for gross beta the team advises performing background measurements using an empty sample planchette as blank.

9.4.5 NERSN laboratory in Slobozia

Verification tasks with regard to the automatic dose rate monitoring equipment are explained in chapter 9.3.3.

General

The verification team visited the NEPA laboratory in Slobozia, which handles a large amount of environmental radiation monitoring samples (an average total of 160 samples per month), although there are only 3 people employed for the radiological measurements.

Sample reception and registration

The sample preparation room was clean and in good order. The samples come with a special form containing detailed information on the collection. A unique code is attributed to each sample, allowing identification of sample type, collection time and collection location.

The sample reception room is equipped with an evaporator, a drying cabinet and furnaces. After preparation the samples are placed in small plastic or glass containers for measurements. The verification team noted that labels are placed on the cover of the containers.

Equipment

The laboratory is equipped with a 'new' gross alpha/beta measurement system *Thermo Electron FHT1100* with dedicated software. The verification team was informed that the system has problems with high background values and therefore was not operational.

The laboratory has also an old, but functional beta-counter system. Calibration controls and weekly stability tests of the system are performed with PHARE-funded commercial Sr-90/Am-241 standards of Czech origin; standard certificates were made available to the verification team.

Measurement results are typed into *Excel* files and kept also on paper. The laboratory does not have a centralised data server.

The laboratory has two UPS systems for 5 hours operation in case of an electrical current failure.

Traceability

The verification team performed a traceability control of an aerosol sample from the SSRM station Slobozia taken on 12 March 2007. All records were found. However, a slight difference of 0.06 Bq/m^3 in the values on the paper format versus the computer file was noticed. This was due to the fact that the programme used for the calculations had been changed and the paper version was not updated.

Reporting

The reports are sent weekly and monthly to NRL in form of *Excel* data sheets (by e-mail), and from there to CNCAN in form of centralised reports.

Archiving

The results are kept on PC file and paper. All results are sent to NEPA Bucharest where they are also stored. Filter papers are archived in the Constanța laboratory; other samples are destroyed after reporting.

Air monitoring system

In its backyard the laboratory also operates a PHARE-funded aerosol sampler. The air sampler suction head is at 2 m above ground. The system does not provide continuous air monitoring; the daily operation time is 10 hours (between 3:00 hr and 8:00 hr and between 9:00 hr and 14:00 hr). The device has a programmable pump control, which regulates the airflow to 5 m^3/h. There is a display which shows the current airflow, total sampled volume from the start of the system, temperature and the air pressure.

The glass fibre filter (*Matefin*, 37 cm diameter) has a retention coefficient of 95%. After removal the filter is measured after 3 min, 20 hr and 5 days for gross beta. Gamma spectrometry is performed at the end of every month.

The system is equipped with a UPS battery connected to a solar panel in case of power supply failure. The battery ensures 24 hours autonomy.

Atmospheric deposition

The laboratory has a standard dry/wet deposition collector situated in the laboratory building backyard. Collection area of the device is 0.3 m^2. The collection bucket is emptied daily if there is precipitation; 250 ml of the total sample volume is used for tritium analysis and the rest for gross beta analysis. If there is no precipitation one litre of distilled water is used for rinsing the device. Distillation for tritium analysis and liquid scintillation counting are done at NRL in Bucharest.

The measurements for total beta are done immediately and after 5 days.

Water sampling

The laboratory samples on a daily basis 3 litres of surface water from the Ialomița River, at the entrance of Slobozia town and one litre of drinking water from the tap of the laboratory. Samples are collected for total beta and gamma spectrometric analysis.

Uncultivated soil

Sampling for total beta analysis is weekly. Every Thursday, a volume of 10x10x5 cm^3 is collected. The sample is dried and the measurement is done after 5 days. The verification team notes that the location is well marked with a string.

For gamma spectrometry (performed at SSRM Constanța), sampling is performed once a year, in July.

Vegetation

The procedure is similar to the one used for soil. Weekly, the 'spontaneous' vegetation and grass is cut on a surface of 1 m^2.

An annual sampling is performed on local fruit (apricots, grapes, fresh nuts and mirabelles) and vegetables (tomatoes, zucchini, and cucumbers). Yearly analysis of local wheat is part of the routine programme.

The samples are sent together with a special form to the SSRM station laboratory in Constanța where gamma spectrometric analyses are done. The results are reported to NRL in Bucharest.

Total beta analysis is done locally in Slobozia.

Milk

Sampling is done weekly from local producers.

The verification team advises the laboratory to review the sample labelling practises in order to minimise the possibility of human error in sample handling. It advises to update result printouts in case a newly installed result calculation program leads to data changes.

9.4.6 NERSN laboratory in Cernavodă

The verification of this laboratory which is prominently involved in the regulatory control of the Cernavodă NPP is described in chapter 9.2.2. This includes also tasks within the national monitoring programme.

9.4.7 NERSN laboratory in Constanța

General

The verification team visited the laboratory situated in the building of the Regional Meteorological Agency.

Verification tasks with regard to the automatic dose rate monitoring equipment are explained in chapter 9.3.4.

The laboratory is a "24 hr type" station with 5 persons working in shifts of 12 hours (0900-2100-0900). The lab also performs gamma spectrometry on samples from other NERSN stations (Slobozia, Călăraşi, Cernavodă, Tulcea, Sfântu Gheorghe, the high mountain stations and Moldovian stations), some of them in the context of the Cernavodă NPP monitoring .

The laboratory usually measures more than 100 samples per month, at some times only 20 (from Constanța and Cernavodă the samples come daily). The programme contains standard samples and special samples (i.e. all the waters). Samples from the other stations are received according to each station's programme; they are stored for three months. After this period they are measured in a batch

The verification team was informed that in total around 1100 samples are measured annually. At the time of the visit the laboratory used only one gamma spectrometer for measurement.

The team was informed that the laboratory still has old equipment in its inventory. Devices that currently still are installed in the LEPA building in downtown Constanța will be moved to the current location.

Sampling tasks

Atmospheric deposition

The verification team noted the wet/dry deposition (NEPA 'standard' design) sampler located in the meteorological garden. A second sampler (tritium collector) is mounted nearby, attached to the meteorological mast by chain to avoid being stolen. Sampling is done only when it rains.

Vegetation

Vegetation sampling is performed biannually on a one square meter spot situated outside the SSRM building.

Soil

A volume of 10x10x5 cm^3 is sampled twice a year at the same location as is the vegetation sample.

Water

The verification team was informed that SSRM Constanța provides measurement of waters from the Black Sea and the littoral natural lagoons. Once per month samples of three litres each are collected from these environments. One litre is evaporated for gross beta measurement, one litre for gamma spectrometry and 250 ml are sent to NRL Bucharest for tritium analysis.

Sample registration and preparation

Upon arrival in the laboratory the samples do not have labels. The samples are noted upon their arrival in a log book. Labels are placed on the lid of the recipient bottles.

Air filters are pressed into a standard container using a manual hydraulic press.

For measurement, the samples are accompanied by a form which indicates the type of sample and the analysis to be done.

Equipment

The verification team noted that the gross alpha counter (Belorussian device) is not connected to the data PC; data transfer is via a USB stick.

In case of current failure the laboratory's measuring devices are connected to UPS.

Gamma spectrometry

The team verified the gamma spectrometric equipment. One gamma spectrometer was bought in 2001. The HPGe detector is from *Ortec* and has 13% relative efficiency. The detector endcap is covered with plastic to avoid contamination; no sample centering device is used. The laboratory operates the integrated spectroscopy system *Ortec 92X Spectrum Master™* with *Ortec Maestro™* analysis software. The device has a Pb shield without Cu lining.

A second gamma spectrometry chain was purchased within a PHARE Program in 2006. The system is from *Canberra* comprising an HPGe detector with 38% relative efficiency and 2.1 keV FWHM resolution in a *Canberra* lead shield. Analysis is done via *Canberra Genie* software including monthly a full run of the *Genie* QA system. For analysis corrections *Canberra ISOCS* is used. The personnel showed that they have good knowledge to operate the system. At the time of the visit the system was not yet in routine function. Peak shape information is not shown in the spectrum analysis report, however, it is when performing checks with the control software.

Long background measurements (300 000 seconds) are performed every ca. 3 months; short 3000 sec measurements are done weekly for checks.

The detector dewars are filled with liquid nitrogen weekly; each filling is marked in a log book.

The verification team noted that the gamma spectrometry room is air conditioned to 16°C to avoid temperature drift problems.

The verification team also visited the data verification room with a PC for transmission software (e-mail or print/fax). The room also housed two old total beta measurement devices (one with *Berthold* NIM equipment, one with *Bicron Labtech* equipment).

QM / QC

The laboratory is not notified by CNCAN (also NERSN's other SSRM laboratories are not). Accreditation is planned. The verification team was told that currently the laboratory handles the majority of the NERSN samples in Romania, in particular for gamma spectrometric measurements, with lack of equipment and personnel and is seen somehow as the 'national reference laboratory'.

The verification team saw that instructions are in place; data sheets, certificates and procedures are orderly; the measurement log book is detailed; however, on some forms signatures of persons responsible for a specific task were missing. Validation of sample results is as follows: one person performs the measurement, another one verifies the results; remarks are put down on the printout (however not signed). The staff involved knows the system very well.

The verification team was informed that since the beginning of 2007 data on calibrations are stored in a database. Calibration of the beta counter is done using Sr-90/Y-90 standards.

Traceability

The verification team performed a traceability control of an aerosol sample from May 2003. All records were found and the values were matching. Peak shape and other spectral features did not show any specific irregularities.

Archiving and reporting

The results are archived since 2001.

The reports of gamma nuclide determinations are sent to NERL. Since the NERSN SSRM laboratory at Constanța is the station that currently performs most of the gamma determinations on national level, it has access to the central database. The laboratory has also its own local database created in *MS Access* in 2000. Data are backed-up on CD-ROM. Data since 1962 (when the laboratory was created) are archived on paper.

For global beta results another type of report is used.

Samples to be measured at NERL in Bucharest are sent by courier or by car.

The verification team encourages accreditation according to ISO 17025.

The verification team suggests exploring methods to improve change of custody procedures by e.g. frequent and regular signing of associated forms and documents.

The team suggests checking if the available equipment and number of personnel is sufficient for performing all gamma spectrometric measurements currently foreseen.

9.5 OTHER VERIFICATION ITEMS

9.5.1 Ministry of Public Health related institutions

General

Constanța Public Health Authority is the implementing body for the national public health programme at local level. The institute operates a radiation hygiene laboratory, covering Constanța and Tulcea districts. For Tulcea there is a designated person for sampling and helping with other tasks as required. A representative of the Institute of Public Health Bucharest was present during the visit and informed the verification team that the institutions linked to the ministry have several executive tasks, such as:

- To monitor the health of the population from the region and measure food and drinking water.

  The total population of Tulcea and Constanța territory is around one million inhabitants.

- To evaluate the situation regarding the health of the population residing around the Cernavodă NPP by special programmes for the NPP (radioactivity and health status checks). These are performed by the radiation hygiene laboratory with the support of the Cernavodă NPP.

  The team was told that with regard to the operation of the Cernavodă NPP at 60 km distance from Constanța city the institute would give importance to cover a larger territory (four additional counties) in order to offer a better control of radioactivity in products for human consumption and drinking water. New plans for improving the system in the health administration of the region have been set up. For the time being foodstuffs and drinking water analysis is done according to the national monitoring programme coordinated by the Institute of Public Health in Bucharest.

  Personnel from the institute go to the Cernavodă area to fixed, pre-selected sampling points using a special vehicle. Analysis results are compared to data from before the beginning of the NPP operation.

- To provide assistance to Constanța harbour by giving advice with regard to food, consumer product and building material control (e.g. with regard to the positioning of a portal monitor. This monitor is currently not located on the main access road and thus is not able to check all containers handled).

  Such assistance has not yet been fixed but an agreement between ANSVSA and IPH is foreseen for the near future. ANSVSA does not have a well equipped laboratory of its own; necessary measurements could be performed in the laboratory of IPH at Constanța.
- To provide licences and authorisations in the medical area.
- To transport radioactive sources and radioactive waste in the medical field.
- To provide assessments concerning radioactivity in building materials and to evaluate the radiation exposure of the population by checking the levels of Ra-226.

  NORM matters are included in the sanitary standard. No elevated radon levels or radon risk areas have been identified in the region.

The verification team strongly recommends setting up a stable co-operation between all authorities involved in food customs control. It strongly encourages formalising this by defining and distributing tasks and responsibilities. Protocols and procedures should be developed and regular exercises should be held in this context.

Sampling

Additionally to the type of sampling performed by the hygiene laboratory as described in Chapter 7.3 measurements are provided for the following: quarterly for surface water (Danube canal and Black Sea), aerosols, and atmospheric deposition and yearly for wine, sand, soil, and 'spontaneous' vegetation. All the samples come from the region. Usually, for foodstuffs and drinking water there are ca. 50 samples per month.

Sample reception and registration

After the collection a sample description form is created for each individual sample and a unique number is attributed.

Sample information is manually introduced in an electronic register on a computer.

Equipment

The maintenance of the devices is ensured by firms accepted by CNCAN.

The laboratory has a UPS sufficient to supplying power for the most important devices.

For its radioactive sources the laboratory has an authorisation from CNCAN.

Gamma spectrometry

For gamma spectrometry only one physicist is employed in the laboratory, several other staff members are trained to perform basic tasks. At the time of the visit the physicist was assisted by a specialist from Bucharest for method developing.

Mixed radionuclide sources used for calibration are from U.S. Mixed Analyte Performance Evaluation Programme (MAPEP) intercomparisons (Cs-137, Cs-134, Co-60, Eu-152, Am-241 and K-40 in KCl reference material).

In 1999 the laboratory received a HPGe with 35% relative efficiency and 1.9 keV resolution from *Canberra* with an *Oxford* shield (steel, 10 cm Pb, Cu) and *target systemelectronic GmbH winTMCA* software. All documentation is available, including manuals and data sheets. One geometry is calibrated. The original calibration had been done by the national bureau of metrology with a large set of sources. Efficiency checks are done monthly using a Eu-152 source.

Background is measured for 60 000 seconds and checked weekly (same time as for sample measurement).

For final result calculation raw results are taken from the measurement; calculations are done by hand in a booklet; no electronic link exists between gamma spectrometry and the result sheet, only manual notes on paper.

> *The verification team advises using an Interface to e.g. an Excel sheet and do calculations with a PC program.*

LN_2 refilling is done every 2 weeks.

The laboratory also owns a *Canberra* portable HPGe (35%, 1.8 keV), which is currently not used.

Alpha/beta measurements

The laboratory has an *Oxford Tennelec Series 5* alpha/beta low level measurement system. The system comprises a guard detector in anticoincidence and a sample changer using 2" planchettes and a PC for data management. Ar-Methane as counting gas comes from *Linde*, Constanța. Calibration is done with Am-241 and Sr-90; calibration checks are monthly, background measurements bimonthly.

The LSC device in the laboratory – *Beckman LS6500* – is only used for the measurement of H-3 in drinking water (samples from Cernavodă, Tulcea, Constanța) and channel water from Cernavodă.

For drinking water the laboratory follows the WHO recommendation (i.e. alpha and beta screening and measurement of K-40 etc. and Po-210 if needed). The EC Drinking Water Directive is implemented in Romania; five laboratories are adequately equipped for analysis.

Quality assurance, archiving and reporting

The institute has a license for transporting radioactive material, including hospital sources.

The hygiene laboratory was accredited for radiobiological measurements, including food measurements by gamma spectrometry, according to ISO 17025 on 25 June 2006 for a period of four years, by the national accreditation organism, RENAR.

All measurements are recorded in the sample register and are reported annually to the Institute of Public Health in Bucharest.

For nuclear facilities related monitoring values are reported every 3 months. The IPH archives the data in its database and sends its reports to the MPH. Values higher than the MDA are processed for dose assessment.

Archiving is on paper since 1975.

The verification team traced the measurements of a sea water sample from Mamaia. Unfortunately all information on this sample was lost and Windows had to be re-installed. This lead to a loss of all older information and data; no archiving on an external medium existed. (E.g. no CD-ROM was available because of the lack of a CD burner).

> *The verification team advises introducing an archiving system on an external medium. It also advises setting up the IT system in such a way that a loss of programs or data can be minimized (e.g. partitioning the hard disk appropriately and using one drive for data; or several hard disks; or a network solution).*

9.5.2 Foodstuffs monitoring by ANSVSA

General

The verification team visited the central laboratory of ANSVSA in Bucharest. The laboratory is situated in an old building behind a busy vegetable and domestic goods market.

The laboratory consists of several measurement rooms. Only two persons work in the laboratory.

> *The verification team points out that the laboratory would benefit from a new and modern laboratory facility specially constructed for radioactivity measurements.*
>
> *The verification team suggests ensuring that enough trained persons are available to be able to manage the measurement workload, also during the holiday periods.*

Sample reception

The official sampling programme is approved annually by the National Sanitary Veterinary and Food Safety Authority. In addition to the official programme, measurements are performed also on commercial basis.

The samples are taken by official veterinaries or state authorised inspectors in the framework of the Strategic Program for Sanitary Veterinary Surveillance. Sample selection is done by an accredited veterinary doctor.

The samples arrive at the laboratory along with their collection data. Samples are registered at the reception desk with a unique sample number (this number can be found in all laboratory registration handbooks). No electronic registration is provided and there is no central sample database for the laboratory; the verification team was informed that implementation of a database is planned for the near future.

Typical products measured in the lab are milk, eggs, spices, meat (pork, beef, poultry), fish, marine products, canned food, cereals and dried products. Additionally the laboratory performs measurements of water samples from the food industry and animal farms.

Radioactivity measurements

The laboratory has a low resolution NaI(Tl) gamma spectrometry system (*IFIN-HH* Bucharest) and a high resolution HPGe gamma spectrometry system (*Princeton Gamma-Tech - PGT*, USA, 20% efficiency). The measurement software is either *GAMMAPLU*S (*IFIN-HH* Bucharest) or *QuantumGold* (*PGT*, USA). Calibration for energy and efficiency is done each time a sample is measured. The laboratory has calibration logs for each detector. Calibration sources are produced by *IFIN-HH* Bucharest. There are closed volume sources of the sample measurement geometry (Cs-134 and Cs-137 with water equivalent density base and zeolite base; Eu-152, Ba-133). Density correction is performed with special software. The verification team was informed that the laboratory measures and reports only Cs-134 and Cs-137.

In addition there is one mobile NaI(Tl) gamma spectrometer (*SAM 935*, *Berkeley Nucleonics Corporation*), provided with an MCA with 1024 channels and software for quantitative analysis of radionuclides (*Quantum NAID*, internal calibration with internal Cs-137 point source). With this equipment it is possible to determine the dose rate for 5 radionuclides simultaneously, at the user's choice.

The verification team was informed that recently there had been liquid nitrogen supply problems.

The measurement room is very warm, since there was insufficient cooling available.

The laboratory is equipped with UPS units, providing 10 minutes autonomy in the event of a power outage.

> *The verification team suggests considering an extension of the measuring capability to other gamma emitters besides Cs-134 and Cs-137 and, if deemed feasible, also to alpha/beta emitters.*
>
> *The verification points out that in order to ensure measurement capability it is important to have a reliable source of liquid nitrogen, preferably with back-up arrangements. Additionally, in order to ensure equipment stability it would be helpful to control the temperature in the counting room.*

Quality assurance, archiving and reporting

The laboratory is ISO 17025 accredited for a period of 4 years for radionuclide analysis on animal origin products and feedstuff products. (RENAR accreditation No. 190-L “Determination of the specific activity of the radionuclides Cs-134 and Cs-137 through low resolution gamma spectrometry with NaI(Tl) detector”).

Measurements are done according to the quality plan of the laboratory. The procedures are documented on paper and electronically.

The verification team performed a traceability control of a meat sample taken from a public slaughterhouse from 29 May 2005 (18665). All records were found.

All the registers containing results are kept since 1974 (founding of the laboratory). Data back-up is maintained on a HD drive.

Reports are prepared monthly and quarterly. If there is a sample with a radioactive content exceeding the maximum accepted levels, the Rapid Alert System for Food and Feed is initiated.

Reports are sent to the Department of Epidemiology and Veterinary Public Health, Bucharest. Samples are stored until the report is ready; after which they are destroyed.

The verification team was informed that due to lack of funds the laboratory rarely has an opportunity to participate in intercomparison exercises and emergency exercises. However, the laboratory participated in the *ConvEx-3* international emergency response exercise in 2005.

> *As a matter of good laboratory practise, the verification team advises the ANSVSA's laboratory to seek opportunities to participate in international intercomparison exercises.*
>
> *The verification team suggests ensuring appropriate training for the staff involved in radioactivity measurements.*

9.5.3 Marine monitoring by the National Institute for Marine Research and Development, "Grigore Antipa"

The radiological laboratory of the national marine institute functions according to a CNCAN notification. The laboratory has only very little involvement in the national routine monitoring, performing nearly only research tasks and participating in international projects (e.g. Black Sea related, IAEA sponsored). Three persons are working in the laboratory, one senior researcher and two assistants.

During the EC team verification visit, the measuring devices of the radiological laboratory were not in operation. However, the team acknowledge the existence of the following measuring systems:

- a *TriCarb1000TR* liquid scintillation counter received from IAEA for C-14 measurements. This device was given with the aim of improving the scientific capacity of the laboratory.
- an old gamma spectrometer with an *Ortec* HGPe detector of 10% relative efficiency and a *Norland 5500* multichannel analyser, also received from IAEA. At the time of the visit, the device was experiencing some technical problems.
- an old beta measuring device from *Nuclear Electronics*.

> *The verification team suggests involving the laboratory closer in the national routine monitoring programme for environmental radioactivity, with respect to marine samples. To fulfil such a task, according staffing and supply with equipment need to be made available.*

9.5.4 Food import control by the Romanian Customs

General

The verification team visited the customs control facilities and associated laboratory in the main Romanian Black Sea Harbour in Constanța.

Portal vehicle monitor

The verification team verified also the container radiation monitoring system installed at the customs container X-ray inspection facility. The facility has a *THSCAN RM2000* system for measuring gamma radiation in containers. The system is able to alert on high radioactivity, but does not perform any quantitative measurements.

The verification team noted that the radiation measurement system is installed as a separate subsystem in the same facility with the container X-ray investigation system. The number of measured trucks is around 500 per month. This means that only some 10% of the containers transported through the harbour are actually monitored for radioactivity. Selection of containers for inspection is made by a separate customs risk analysis group.

The team was informed that if radiation is found, the customs officials are not allowed to open the container. In such a case the police and the public health authority would be contacted for further investigations.

The verification team points out that a more effective location for the radiation monitoring systems would be at the harbour exit, where it could facilitate radiation monitoring of all containers leaving the harbour area.

9.5.5 Laboratories involved in food import control

Currently only one laboratory is involved in the measurement of food imports at the main Romanian harbour at Constanța. The verification team visited the laboratory of the Sanitary Veterinary and Food Safety Directorate for measuring samples taken by the customs in Constanța. The laboratory measures some 300-400 samples per year; Romania's EU-accession has reduced the number of customs samples, since only the EU external borders are controlled.

Sample receipt

Samples arrive in the laboratory in sealed boxes. Each sample receives a laboratory number. Data is kept on paper only; there is no central database.

Radioactivity measurements

Radioactivity measurements are carried out with a lead-shielded NaI(Tl) low resolution gamma spectroscopy system (*PGT*). Acquisition of an HPGe system is being considered.

Typically 600 s counting time is used. If results indicate a value below the minimum detectable activity (MDA), the sample activity is indicated as <MDA in the report. There is no formal requirement for the MDA in Romania.

Samples are stored only if abnormally high activity (>100 Bq/kg) is found; otherwise they are discarded after measurement.

System calibration is performed using Cs-137, Cs-134 and Eu-152 standards. Density correction is applied on sample measurements.

The verification team advises CNCAN to consider establishing a common criterion for the measurement MDA in laboratories carrying out environmental or foodstuffs radioactivity measurements.

The verification team supports the intention to move to an HPGe detector. In addition it would be good to have more than one system available for measurements.

Quality assurance

The laboratory is not accredited, but it has CNCAN notification. There is an intention to achieve accreditation according to ISO 17025 in the future.

The laboratory has participated in quarterly intercomparison exercises with the Public Health Institute, but not in any international exercises.

The verification team encourages the laboratory to proceed towards accreditation and to actively participate in intercomparison exercises.

10 "HORIA HULUBEI" NATIONAL INSTITUTE OF RESEARCH AND DEVELOPMENT IN PHYSICS AND NUCLEAR ENGINEERING (IFIN-HH)

10.1 INTRODUCTION

IFIN-HH is located in Măgurele town, in the southeast part of Bucharest, near the ring road of Bucharest, at 8 km straight line from the City centre. The institute is under the coordination of the Ministry of Education, Research and Youth, National Authority for Scientific Research.

IFIN-HH has as main nuclear facility, a *VVR-S* research reactor, currently not operating but in conservation. By a Governmental Decision, in April 2002, the *VVR-S* reactor was shutdown permanently for decommissioning. The *VVR-S* reactor is the first major nuclear facility in Romania that will be decommissioned. For this purpose, an immediate dismantling strategy was selected. The implementation of the strategy is based on the IFIN-HH Decommissioning Plan and Project Management. The spent nuclear fuel assemblies resulting from the operational period are planned to be removed from the reactor building before starting the decommissioning process, which is planned to start soon. For this purpose, a detailed plan has been submitted to CNCAN for approval. RENAR already approved the quality manuals of several laboratories of IFIN-HH, performing various measurements in the nuclear field; other laboratories were designated by CNCAN as laboratories notified for the nuclear field and accredited by RENAR.

In the neighbourhood of the *VVR-S* Research Reactor facility the following research and production units are situated:

- Radioisotopes Production Centre (3 buildings);
- Radioactive Waste Management Department (5 buildings);
- Detectors Laboratory of Nuclear Physics Department (2 buildings);
- Heavy-Ions Van de Graaff-Tandem Accelerator;
- Subcritical assembly Zero-Power Nuclear Reactor;
- Thermal Plant (4 buildings).

All expenses related to repair and maintenance of the on-site national installations (*VVR-S* Research Reactor, Tandem Accelerator, Multipurpose Radiation Processing Irradiator, Radioactive Waste Treatment Plant, Cyclotron Accelerator) and of site national interest installations (National Repository for Radioactive Waste Băița-Bihor) are covered by the state budget.

CNCAN supervises the institute's quality management systems and controls its tasks.

Within the frame of Euratom research, the institute has a few contracts in the area of nuclear fusion. IFIN-HH participated in several PHARE projects on decommissioning, upgrade of the radioactive waste treatment facility, and upgrade of the radioactive waste repository.

IFIN-HH is involved in the assessment of consequences and contamination in case of an accidental release of radioactivity from the Cernavodă NPP. For this purpose and for any local emergency the real–time decision support system *RODOS* has been installed at IFIN-HH.

IFIN-HH currently employs 800 people. More than 400 work in the research and development area.

IFIN-HH operates mobile gamma spectrometric systems, gaseous effluent sampling systems, mobile radiological equipment and a dedicated car.

The site has access has to the main road of Bucharest-Măgurele and to the southern part of the railway ring of Bucharest.

The verification team visited the Research and Radioisotopes Production Centre Department, in particular with a view to seeing the facilities dealing with radioactive waste and the measuring laboratories involved in monitoring. The team was informed that currently sealed sources of Co-60 and radium (up to 100 Ci) and I-131 for nuclear medical applications are produced. This leads to some 80% of the discharges of the institute. There are plans to restart Mo-99 production. For physical protection on weekends the building is sealed.

10.2 DISCHARGE MONITORING

The discharges of radioactive liquid and airborne effluents are regulated. There are administrative limits established for the critical group: 0.1 mSv/y. CNCAN authorizes radioactive discharges to the environment case by case or to the Radioactive Waste Treatment Plant (airborne and liquid).

The monitoring programme is reviewed and approved by CNCAN, and implemented by IFIN-HH.

Monitoring is performed at each unit generating liquid and gaseous effluents. Liquid effluents are preliminarily collected in tanks and then, depending on the radioactivity content, are transferred to the Radioactive Waste Management Department for storage, treatment and conditioning. At present, the radioactive liquid treatment plant is out of function and is to be replaced with new equipment, with PHARE funds.

The Nuclear Reactor has not discharged liquid effluents to the Radioactive Waste Management Department since 2002, and this department does not discharge liquid effluents to the Ciorogârla River.

The sewage system of Măgurele village is still owned by IFIN-HH which makes IFIN-HH responsible for appropriate monitoring. In the future it will belong to the village community.

10.3 RADIOACTIVE WASTE MANAGEMENT

Solid radioactive waste is managed using the existing Radioactive Waste Treatment Plant on site and the National Repository for Radioactive Waste at Băița Bihor. Both are to be refurbished.

The verification team was shown the site where old, corroded waste drums are managed. Their transfer to the repository has been stopped several years ago, and the old 200 l drums are now placed into new 420 l drums, the layer between the walls being filled with fresh concrete.

The old drums storage hall contains some 100 to 150 drums. For characterisation of each drum tests are performed by measuring gamma dose rate at surface and at 1 m distance; a gamma spectrum is obtained using an *ORTEC* device, giving information on gamma activity and – by detection of activation – on neutron emitters. The team was informed that until now no neutron emitters have been found.

With regard to the 'neptunium issue' the team was shown two points in the yard, marked in black. The team was told that the rumour about a neptunium contamination was due to an error in the interpretation of the gamma spectra by the person doing the measurements. An investigation by IFIN-HH as advised by CNCAN and overseen by external experts showed that no real contamination with Np exists.

The verification team was also shown old storage vaults that for more than 25 years had not been opened. Two years ago IAEA and CNCAN requested IFIN-HH to open them. After necessary preparatory work, during an IAEA inspection and in the presence of CNCAN the vaults were opened; three cells were found empty; one cell contained aluminium claddings from an irradiation facility.

The team was also told that in 2002 200 m^3 tanks (ponds) in the underground stopped receiving input from the reactor. Another formerly empty tank of 160 m^3 received in the week before the visit 14 m^3 liquid from radioisotope production because the value was above the limit. The tanks are in good condition.

10.4 ENVIRONMENTAL MONITORING PROGRAMME

A site-related environmental radioactivity monitoring programme is in place taking into account emissions under normal operation, meteorology and hydrology of the Măgurele area, as well as significant exposure pathways. Annually all measurement data are sent to CNCAN.

Within IFIN-HH environmental radioactivity monitoring is a task of the Life and Environmental Physics Department. It comprises gross alpha-beta and gross gamma measurements and gamma spectrometric determination of collected samples, as well as monitoring ambient gamma dose rate at about 1 m above soil surface. Procedures for measuring activities are issued and the devices are calibrated. The measurements are conducted within the Environmental Monitoring Laboratory, the Authorized Laboratory for Personnel and Environmental Dosimetry and the Gamma Spectrometry Laboratory, all of them being notified by CNCAN, based on ISO 17025.

The personnel working in the laboratories for environmental monitoring and sampling are trained for performing all operations according to the procedures. The responsibilities of each person are defined through the organizational structure of each laboratory.

Samples include aerosols, atmospheric deposition, drinking water, surface water from Ciorogârla River, ground water, natural and cultivated flora, river sediment and soil. Collection frequency is between 1 and 90 days depending on the sample type.

Sampling locations are shown in table 4.

Environmental radioactivity includes monitoring with TL dosimeters. The system consists of a *Reader-Analyser RA 94* (located at the Authorized Laboratory for Personnel and Environmental Dosimetry of the Life and Environmental Physics Department) and TLDs (LiF:Mg,Cu,P - based thermoluminiscence detectors of type *GR-200*). There are 40 such TLDs placed on-site and off-site. All TLDs are changed every month. The laboratory was designated by CNCAN as testing laboratory notified for the nuclear field. The laboratory is currently in the process of obtaining RENAR accreditation.

A tower for monitoring meteorological data is situated on the IFIN-HH site.

Table 4: Sampling locations for environmental radioactivity monitoring at IFIN-HH

Sampling locations	Sample Type
Reactor Channel 1	Water, sediment, 'spontaneous' flora, soil
IFA Channel 2	Water, 'spontaneous' flora, soil
Ciorogârla River – upstream	Surface water, sediment
Ciorogârla River - downstream	Surface water, sediment
Ciorogârla River – domestic sludge station	Surface water, sediment
ICAB station	Surface water, sediment
IFIN Group I – Reactor yard	Drinking water, soil
IFA Group II[8]	Drinking water
Wells in the village	Water pipe in channel 1 – reactor ground water
Wells in reactor area	Ground water
"Helen"[9]	Soil, 'spontaneous' flora
Bucharest - Titan (background)	Soil, flora
Forest (FM station)[10]	Soil, 'spontaneous' flora
Village around the channels	Vegetables, cereals, soil, milk, fruit
High voltage station	Soil, 'spontaneous' flora
Pumping station	Soil, 'spontaneous' flora
Mechanical workshop	Soil, 'spontaneous' flora
Life and Environmental Physics Department	Air

10.5 RESEARCH AND RADIOISOTOPES PRODUCTION CENTRE DEPARTMENT

At the Research and Radioisotopes Production Centre Department the verification team was shown discharge related facilities and the associated laboratory.

10.5.1 Aerial discharge monitoring

The maintenance room of the Radioisotope Production Department houses two identical continuous ventilation systems: one in operation, the other on standby.

[8] Within IFA = Institute of Atomic Physics; “IFA Group II” is a name given to a region (group of buildings) of Măgurele platform

[9] Site at IFIN-HH

[10] IFIN-HH's former sewage treatment station

Air from outside is filtered using HEPA filters. The rooms are under a fixed level of depression. The system is water cooled. Routing to areas is according to the radioactivity potential. Altogether there are more than eight branches in the exhaust system. Air from 'clean' areas goes directly to the stack.

Air from the production boxes is led over pre-filters and filters to the stack. Air from shielded cells is led through F5 (99.999%) pre-filters plus charcoal filters to "HEPA" filters (licensed by CNCAN) and then to the stack. All ventilation of the radioisotope production facilities is via the 40 m high reactor stack.

Flow rate in the stack is 100 000 m^3/h during day and 60 000 m^3/h during night. The base value has been calculated at the beginning of the operations (the fans used are still the original ones, thus no change is assumed).

The bypass system for stack monitoring operates in a non-isokinetic way, with a constant flow rate. It contains a vacuum pump with a *F&J Specialty Products* rotameter measuring the air flow (at the time of the visit showing 40 l/min) and the stack monitor itself, consisting of a triethylenediamine (TEDA) impregnated charcoal cartridge, which is changed every two months, the possibility of a paper pre-filter for aerosol collection, a NaI(Tl) detector and an MPP Instruments display. The measuring interval is one hour. At the start of a measurement the device performs a self test that includes alarm functions.

Usually, measured values are in the range 10-20 Bq/m^3. For values higher than 1200 Bq/m^3 a 'stack alarm' is generated. This would lead to checks in the whole production area and may even lead to stopping cell ventilation. If the values are higher than 150 Bq/m^3 (but lower than 1200) a 'local alarm' is triggered; the origin of the signal is checked. In case of a mechanical failure of the system ventilation the back-up system automatically starts and an alarm is displayed in the control room (panel with radioactivity/radiation monitors).

Contaminated filters are provisionally stored and then discarded (never reused).

All electrical connections of the main systems (reactor included) are secured by a diesel generator backup that automatically takes over the power supply in case of electric failure.

10.5.2 Liquid discharge monitoring

Storage of (radioactive) liquids is done in the basement (9 m below ground) of the building to allow filling by gravity. A gamma dose rate device (whose results are displayed in the control room) monitors the radiation level in the room. Six persons are in charge of discharges and sampling.

Four tanks (polyethylene or stainless steel) of 4 m^3 each with pumps for transfer movement are set up. All valves have CNCAN's seals. The tanks are marked R1 and R2 (for probably contaminated liquids), and R3 and R4 (for possibly contaminated liquids). Each tank has 2 mixing pumps. The level of liquid in the tanks is displayed in the control room. A signal appears when a tank is full.

The piping system is double for redundancy purposes. In case of leakage liquids are collected in a sump. If necessary the sump is emptied to R4, generating an alarm signal.

Discharges are possible from each tank to the waste treatment plant.

Each tank has a sampling valve. If a tank is full, after 5 minutes stirring three 1 litre samples are taken: Two are tested in the laboratory of the Life and Environmental Physics Department for gross alpha, beta and gamma activity and in the Research and Radioisotopes Production Department for gamma nuclides respectively; one sample is kept as reference. If the results are within the limits established by CNCAN the evacuation procedure is approved by CNCAN. The tank's seals are broken, the 2nd valve is opened and the liquids are discharged into the Ciorogârla River. The discharge is observed by minimum 2 persons from CNCAN. In case the limits are not kept the liquid is transferred to one of two 9 m^3 buffer tanks situated between the discharge tanks and the radioactive waste plant, for decay (usually of I-131) before release. Sampling is not regularly observed by CNCAN, but CNCAN occasionally verifies sampling and measures the samples.

At the time of the visit tank R3 was full and 'waiting' for the analysis results.

10.5.3 Discharge sample laboratory

The verification team visited the laboratory managing all discharge samples from the site. Three persons work in the laboratory, 80% of the discharges are due to the production of isotopes. Calibration sources for alpha measurement systems (e.g. Am-241 from *LMRI*, France) and for beta measurements (e.g. Sr+Y-90) are kept in isolated cupboards in the corridor together with some discharge samples. The cupboards are locked and two people have access to the keys. The verification team acknowledges also that on the same corridor there are shelves where the paper archive is kept.

On arrival at the laboratory, the samples are marked, and accordingly recorded in a registration book and kept or sent away for analysis.

In the laboratory only gamma spectrometry is performed on discharge samples (aerial and liquid); beta and alpha measurements are done in other units (including sample preparation). The laboratory performs also gamma measurement on the environmental samples.

Equipment

The laboratory operates a *Canberr*a gamma spectrometry system based on an HPGe detector with 25% relative efficiency and NIM electronics. The measuring system is connected to a PC using *Canberra AccuSpec*. A Si(Li) detector has been put in function this year. A back-up system exists in another building.

The detector end cap is plastic covered. The system is shielded with a wall made of 5 cm Pb bricks (swallow tail) and 1 cm copper. Efficiency calibration is done every three years by the IFIN-HH metrological laboratory using their standards (recognised by BIPM, Sèvres, France).

Energy calibration is done daily. The background check is performed two to three times per day, in a routine way, after each sample measurement.

Measuring of samples is usually directly on the detector or at a distance of 45 cm.

The analytical balances used are calibrated yearly. The laboratory has a maintenance contract with a specialised company. The verification team acknowledged the maintenance log and the calibration certificates.

The verification team was informed that the laboratory will buy a new gamma spectrometer system from *Canberra, GammaVision*. The laboratory currently uses French software for efficiency calibration for the various geometries (using a Monte Carlo simulation model for the various distances).

Archive

The PC is not connected to the network. All spectra from 2003 onward are stored; but archiving is not systematically done. All spectra are kept in paper format, however only the most important ones are recorded on diskettes.

> *The verification team recommends building up a proper electronic and systematic archiving system capable of storing all such data.*

10.6 LIFE AND ENVIRONMENTAL PHYSICS DEPARTMENT

The verification team was informed that in this department measurements are done on two types of samples of the environmental and the discharge monitoring programme of IFIN-HH and on other samples coming from other institutions with which IFIN-HH has a contract.

Sampling tasks

The Life and Environmental Physics Department also manages most of the sampling tasks and operates sampling devices.

On the roof of the building an air sampler (*F&J*, Model *DL 28 BE*, series 6034) is mounted, operating five hours per day. The airflow is 20 000 litres/hr. The filters are analysed bimonthly.

Atmospheric depositions are collected bimonthly at the Meteorological Tower.

Surface water is collected daily (two or three litres at each sampling location) and gross alpha, beta, gamma measurements are conducted.

Waste water is collected just from the aperture of the overflow channel before discharging into the river. Domestic water (ground and drinking) are collected from the sedimentary pools, without touching the sediments. These waters are collected daily. Drinking water for the village is partly city supply, partly there are individual wells.

Sediment is collected with a special tool from established locations. The samples are filled in marked plastic bags and kept covered until they are ready to be measured. Soil is collected with a special tool from established locations. There are nine soil and sediment sampling locations. Generally they coincide with water sampling locations. A control location is situated in Bucharest – City.

Samples of natural flora are collected at the same locations the soil samples are taken, in the second and the third quarter of the year. Cultivated flora – lettuce, tomatoes, cabbage, potatoes and grains (wheat, corn) – is taken from producers in the IFIN-HH influence area and a reference area.

Milk samples come from cows raised within the IFIN-HH influence area (i.e. in the Măgurele town, from people who have animals which graze and eat plants from the neighbouring lands) and a reference area. The samples are collected quarterly, at least 1 litre, in labelled plastic bottles. The sample is processed the same day it is collected.

Foodstuffs analysed in the laboratory are generally vegetables produced in the farmhouses of the people in the town of Măgurele.

Sample reception and registration

Sample reception is made according to the laboratory procedure. Every sample arrives with an identification label containing information on the location, type, date, name of the person who took the sample and any remarks.

Equipment

The verification team was shown the following devices:

- A proportional counter for gross alpha, beta measurements, type *AB-S-28*. The acquisition and processing of data is done using *VISTA 2000*-licensed software.
- A gamma measurement system, based on a well type NaI(Tl) detector installation for gross gamma measurements, from *Nuclear Chicago*, USA.
- A mobile HPGe detector.
- An *Ortec* p-type HPGe detector with 33.8% relative efficiency with a shield consisting of Pb bricks. Since also the roof is made of such lead bricks, opening the shield is difficult. The device is still under guarantee; a service contract is foreseen to be signed later.

  Energy checks are performed daily via the K-40 content of the sample. If a deviation of more than 2 channels occurs, the device is energy recalibrated.

  Detector efficiency is assumed to stay stable; an efficiency calibration is only done after performing work on the detector.

  Background measurements are performed from Friday noon to Monday morning, at least once per month.

  Sample measuring time usually is >= 10000 seconds. Measurement logs are available.

  Spectra since 1992 are saved on the hard disks of 2 PCs. The software used can manage several spectra formats.
- The laboratory has also an *Ortec digiDART* portable standalone MCA with 9 hour battery backup, using *Ortec Maestro* software.

The laboratory uses calibration sources based on reference material from IAEA (i.e. from IAEA inter-comparison exercises) and sources manufactured in IFIN-HH by a laboratory having the according

CNCAN notification and an authorisation by the Romanian Bureau of Legal Metrology (BRML). Traceability of the IFIN-HH calibration sources to the international system is assured.

In the sample preparation room the team was shown new sample containers produced according to CNCAN recommendations.

Reporting

Measurement results, detection limits, MDA values and uncertainty values are recorded in ledgers according to procedures. An analysis bulletin is issued on the basis of the measurement results on separate PCs using Excel spreadsheets. Reports on the analysis of the environmental samples are submitted monthly to a special department at IFIN-HH and annually to CNCAN.

Sample storage, archiving

The storage of data, information and results on paper as ledger, bulletin and report is laid down in procedures. The samples are stored appropriately for at least 2 years. The control-samples are kept up to 6 months.

Quality assurance and control procedures

The procedures that are used were revised in 2004, verified and approved by the quality assurance department of IFIN-HH.

Within the Sample Activity Measuring Unit several gamma spectrometric measurements of samples from IAEA intercomparisons between 18 laboratories, which included Cs-137 and Pb-210 in soil, have been made.

The Authorized Laboratory for Personnel and Environmental Dosimetry within IFIN-HH is due to be accredited; the Sample Activity Measuring Unit is notified by CNCAN.

The verification team encourages all efforts for accreditation.

11 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 during and after the verification, was useful.

(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 around the Cernavodă nuclear power plant site as well as the verified parts of the national monitoring system for environmental radioactivity and of the food import control facilities are adequate. The Commission could verify the operation and efficiency of these facilities.

(2) A number of topical recommendations are formulated. These recommendations aim at improving some aspects of discharge monitoring from, and environmental surveillance around the Cernavodă site and the national monitoring system. The recommendations do not discredit the fact that environmental monitoring around the Cernavodă site as well as the verified parts of the national monitoring system for environmental radioactivity are 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 Romanian competent authorities through the Romanian Permanent Representative to the European Union.

(4) The Commission services having competence will closely follow up the progress made by the Romanian authorities with respect to point (2).

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

(6) Finally, 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 04/06

1. Opening meeting at CNCAN premises in Bucharest: Introductions / presentations / programme of the visit (AM)
2. TEAM 1: Verification of the laboratory for the environmental samples at CNCAN in Afumați (PM)
3. TEAM 2: Verification of the NEPA's reference laboratory for radioactivity and the network coordination centre for the National Environmental Radioactivity Surveillance Network (NERSN) at the National Environmental Protection Agency (NEPA) in Bucharest (PM)

Tuesday 05/06

4. TEAM 1: Verification of the laboratory for food and feed stuff control at the National Sanitary Veterinary and Food Safety Authority premises (NSVFSD) in Bucharest (AM)
5. TEAM 2: Verification of the Early Warning System's (EWS) data centre at NEPA in Bucharest (AM)
6. TEAM 1: Verification of the NEPA's monitoring station in Călăraşi, Ilfov County situated in the south-eastern Romania (PM)
7. TEAM 2: Verification of the NEPA's monitoring station in Slobozia, Ilfov County situated in the south-eastern Romania (PM)

Wednesday 06/06

8. Arrival at Cernavodă NPP, Dobrogea County. Site access formalities, introductions, presentations, programme of the visit. (AM)
9. TEAM 1: Verification of the regulatory provision for monitoring/sampling of radioactive discharges of the Cernavodă NPP (airborne and liquid) and visit of the reactor's operations control room. (AM)
10. TEAM 2: Verification of the on-site environmental monitoring/sampling (AM)
11. TEAM 1: Verification of the provision for monitoring/sampling of airborne and liquid discharges by the operator -statutory obligations (PM)
12. TEAM 2: Verification of the operator's laboratory for related environmental radioactivity samples in Cernavodă - monitoring programme (PM)

Thursday 07/06

13. TEAM 1: Verification of the provision for monitoring/sampling of airborne and liquid discharges by the operator (cont.) (AM)
14. TEAM 2: Verification of the off-site environmental monitoring/sampling, Cernavodă, Siliştea, Seimeni. (AM)
15. TEAM 1: Verification of the operator's discharge laboratory. (PM)
16. TEAM 2: Verification of the regulator's site-related environmental monitoring/sampling in Cernavodă and surroundings and NEPA's local laboratory in Cernavodă. (PM)

Friday 08/06

17. TEAM 1: Verification of a representative selection of the regional provisions for the environmental monitoring /sampling programme implemented by the regulator in the south-eastern part of Romania. Verification of NEPA's local laboratory in Constanța. (AM)
18. TEAM 2 Verification of custom's food (import) control facilities in Constanța (AM)
19. TEAM 1: Verification of the laboratories for monitoring of radioactivity in Constanța. Institute of Public Health and Institute for Marine Research. (PM)
20. TEAM 2. Verification of monitoring sites in eastern Romania (Tulcea) (PM)

Monday 11/06

21. Verification of the Horia Hulubei National Institute of Research and Development in Physics and Nuclear Engineering (IFIN-HH), in Măgurele. Presentations and detailed planning of the site visit. Verification of the on-site environmental monitoring and discharge monitoring (AM)
22. Verification of the IFIN-HH off-site environmental monitoring (PM)

Tuesday 12/06

23. Closing meeting at CNCAN premises in Bucharest. Presentation by the EC verification team of preliminary findings (AM)

APPENDIX 2

DOCUMENTATION RECEIVED AND CONSULTED

1. Additional legislation consulted

Laws:

- Law no.111/1996 on the safe deployment, regulation, licensing and control of nuclear activities, ublished, published in the Romanian Official Bulletin part I, no. 552/27.06.2006.
- Law 150/2004 regarding the food and feed safety, amended by the Law 412/2004, published in the Official Gazette no. 959/29.11.2007;
- Law 95/2006, on healthcare reform, Title 1, Public health, published in Romanian Official Bulletin, part I, 372/2006.
- Law 98/1994 on establishing contraventions for public health and hygiene norms, with further modifications and completions, published in OG no.317/1994.

Norms:

- Norms regarding the limitation of the radioactive effluents discharges to the environment (NDR-04), approved by CNCAN President Order No.221/2005 and published in the Official Gazette of Romania, part I, no. 820/09.09.2005
- Norms regarding the monitoring of environmental radioactivity around nuclear and radiological facilities (NSR-22), approved by CNCAN President Order No.275/2005 and published in the Official Gazette of Romania, part I, no. 923/17.10.2005
- Norms regarding the monitoring of radioactive emissions from nuclear or radiological facilities (NSR-21), approved by CNCAN President Order No.276/2005 and published in the Official Gazette of Romania, part I, no. 923/17.10.2005,
- Norms on dispersion calculations for NPP releases in the environment - issued by CNCAN President Order no. 360 / 20.10.2004 and published in the Official Gazette of Romania, part I, no. 1159 bis/08.12.2004.
- Norms regarding the requirements for meteorological measurements at NPP - issued by CNCAN President Order no. 361 / 20.10.2004 and published in the Official Gazette of Romania, part I, no. 1189/13.12.2004.
- Fundamental Norms for Radiological Safety, approved by CNCAN President Order No.14/2000 and published in the Romanian Official Bulletin, part I, no. 404/29.08.2000

Decrees and Orders:

- The Environmental Protection Decree no. 195/2005, approved by Law 265/2006
- MS/MAAPDR/ANPC Order nr. 855/98/90/2002 for the approval of the Norms regarding foods and food ingredients treated with ionizing radiation, published in the Official Gazette no. 218/25.04.2002;
- Ministerial Order no. 880/2006 of the Ministry of Public Health, regarding the organization and functioning of the district authorities for public health, and their structure, published in OG, part I, 656/2006 (Article 5, paragraph 5.3)
- Ministerial Order no. 431/2004, regarding the organization and functioning of the laboratories and departments of ionizing radiation hygiene, within the network of the Ministry of Public Health, published in OG, part I, 368/2004
- Ministerial Order no. 1688/2004 of the Ministry of Public Health, regarding the national public health reports under the national public health programme 1.4., publ. in OG, part I, 89/2005

2. Documents received:

CERNAVODĂ NPP

- "Raport de Mediu" "Environmental Report, 2003.

- "Raport de Mediu" "Environmental Report, 2005.
- Corporate "Nuclearoelectrica" Report, 2005.
- Worksheet produced by the operator for the Unit 2 (Form code PMT-654, Revision)
- Liquid effluents monitoring sheet for the Unit 1
- Authorisation of evacuation of the fluid effluents for Unit 1
- On- an off- site monitoring locations plans.
- NPP PowerPoint presentations at the Preliminary Meeting of 12 March, CE premises, Luxembourg

CNCAN

- Reply to European Commission preliminary information questionnaire in view of preparing the verification activities, 2006.
- "Environmental monitoring around nuclear facilities in Romania. Regulation, licensing, control" PowerPoint presentation at the Preliminary Meeting of 12 March, CE premises, Luxembourg
- "Radiation Emergencies preparedness and response actions of CNCAN", PowerPoint presentation at the Preliminary Meeting of 12 March, CE premises, Luxembourg
- "CNCAN radioactivity monitoring & control programme around Cernavodă NPP", PowerPoint presentation at the Preliminary Meeting of 12 March, CE premises, Luxembourg
- CNCAN's Annual report, 2005

IFIN-HH

- IFIN-HH Reply to European Commission preliminary information questionnaire in view of preparing the verification activities, 2006.
- IFIN-HH PowerPoint presentation at the opening meeting, on 04 June 2007, at CNCAN's premises in Bucharest

NEPA

- "Monitoring Programme for Environmental Radioactivity in Romania" PowerPoint presentation at the Preliminary Meeting of 12 March, CE premises, Luxembourg
- Raport de Mediu" "Environmental Report, 2003", LEPA-Constanța.

Public Health Authority (ASP and NSVFSD)

- "NSVFSD – Laboratories Network" PowerPoint presentation at the Preliminary Meeting of 12 March, CE premises, Luxembourg
- "Monitoring of Radioactivity in Drinking Water and Foodstuffs" PowerPoint presentation at the Preliminary Meeting of 12 March, CE premises, Luxembourg

OTHER

- "PHARE 2002" Standard Summary Project Fiche with respect to the implementation of an adequate environmental radioactivity monitoring and reporting system in Romania
- "Nuclear Power Development in Romania", Ministry of Economy and Commerce's PowerPoint Presentation on 24 November 2005, EC premises, Luxembourg
- "Radioactive waste management in Romania", Ministry of Economy and Commerce's PowerPoint Presentation on 24 November 2005, EC premises, Luxembourg

3. Web sites consulted

- National Commission for Nuclear Activities Control (CNCAN) www.cncan.ro
- S.N. Nuclearoelectrică S.A. Cernavodă www.nuclearelectrica.ro
- Centrala Nuclearoelectrică (CNE) Cernavodă www.cne.ro
- Environmental protection Agency (NEPA) www.anpm.ro
- Holia Hulubei National Institute of Nuclear Physics and Nuclear Engineering IFIN - HH www.nipne.ro
- Institute of Public Health www.ispb.ro

APPENDIX 3

NPP Cernavodă – ENVIRONMENTAL SURVEILLANCE
Monitoring/Sampling Provisions

Type	Emission category	Exposure pathway	Measurements/Measuring devices
Indicator	Noble gases Aerosols iodine Gaseous C-14 Particulates	External exposure and inhalation	TLD
Indicator	idem	idem	Air (deposition on particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Indicator	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Background	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD
Background	idem	idem	Air (deposition particulate and iodine filters) Water vapours in air TLD

Type	Emission category	Exposure pathway	Measurements/Measuring devices
Indicator	idem	idem	-TLD
			Fish
Indicator	idem	idem	Milk, beef meat
Indicator	idem	idem	Vegetables, fruits, meat
Indicator	Tritium in water Particulates in water C-14 in water	External irradiation due to soil contamination	Irigated soil
Indicator	idem	idem	Irigated soil
Indicator	idem	External irradiation due to soil contamination	Sediment
Background	idem	N/A	Sediment
Indicator	idem	idem	Poultry meat
Indicator	idem	Ingestion of fruits	Fruits
Indicator	idem	Ingestion of vegetables	Vegetables
Indicator	idem	Water ingestion	Water
Indicator	idem	Water ingestion	Water
Indicator	idem	Water ingestion	Water
Backgrounds	N/A	N/A	Warwe
Indicator	Tritium in water	Ingestion of fruits and vegetables	Vegetables, fruits, grains
Indicator	Particulates in water		Fish
Supplementary*	N/A	N/A	Deep underground water
Supplementary*	N/A	N/A	Deep underground water
Supplementary*	N/A	N/A	Infiltration underground water
Supplementary*	N/A	N/A	Infiltration underground water
Supplementary*	N/A	N/A	Rain water
Supplementary*	N/A	N/A	Water
Supplementary*	N/A	N/A	Soil and vegetation
Supplementary*	N/A	N/A	Wet deposition from potable water
Supplementary*	N/A	N/A	Wet deposition
Supplementary*	N/A	N/A	Infiltration underground water
Supplementary*	N/A	N/A	Infiltration underground water
Supplementary*	N/A	N/A	Infiltration underground water
Supplementary*	N/A	N/A	Infiltration underground water
Supplementary*	N/A	N/A	Wet deposition
Supplementary*	N/A	N/A	Soil and vegetation
Supplementary*	N/A	N/A	Soil and grapes
Supplementary*	N/A	N/A	
Supplementary*	N/A	N/A	Soil, vegetation and potable water
Supplementary*	N/A	N/A	Fish

Type	Emission category	Exposure pathway	Measurements/Measuring devices
Supplementary*	N/A	N/A	Potable water, fish
Supplementary*	N/A	N/A	Potable water
Supplementary*	N/A	N/A	Rain water
Supplementary*	N/A	N/A	Rain water

**Supplementary locations were established for sample types wich are not included in the identified exposure pathways*

APPENDIX 4

NPP CERNAVODĂ - DISCHARGE AND ENVIRONMENTAL MONITORING PROGRAMME

Media	Analytical frequency
Particulates in air (filters)	Monthly-Gaseous emissions <MDA
	Weekly - MDA< Gaseous emissions <6%DEL
	Daily - Gaseous emissions >6% DEL
Iodine in air (filters)	Quarterly- Gaseous emissions <MDA
	Weekly - MDA< Gaseous emissions <6%DEL
	Daily - Gaseous emissions >6% ADEL*
Tritium in air (molecular sieve)	Monthly
	Weekly - 1%DEL < Gaseous emissions <6%DEL
	Daily - Gaseous emissions >6% ADEL*
C-14 gaseous	Monthly
	Weekly - 1%DEL < Gaseous emissions <6%DEL
	Daily - Gaseous emissions >6% ADEL*
TLD	Monthly
Surface water	Monthly
Water (Condenser Cooling Water duct)	Weekly
Rain water	Weekly
Underground infiltration water	Monthly
Deep underground water	Monthly
Soil	Twice in a year
Sediment	Twice in a year
Milk	Weekly (gamma spectromety and H-3)
	Monthly (gross beta and C-14)
Wet atmospheric deposition	Monthly
Fish	Twice in a year
Meat	Annually
Vegetables	Annually
Leafy vegetables	Twice in a year
Fruits	Annually
Wild vegetation	Monthly (May - October)

DEL: Derived Emission Limit

**ADEL: Annual Derived Emission Limits*

MDA: Minimum Detectable Activity

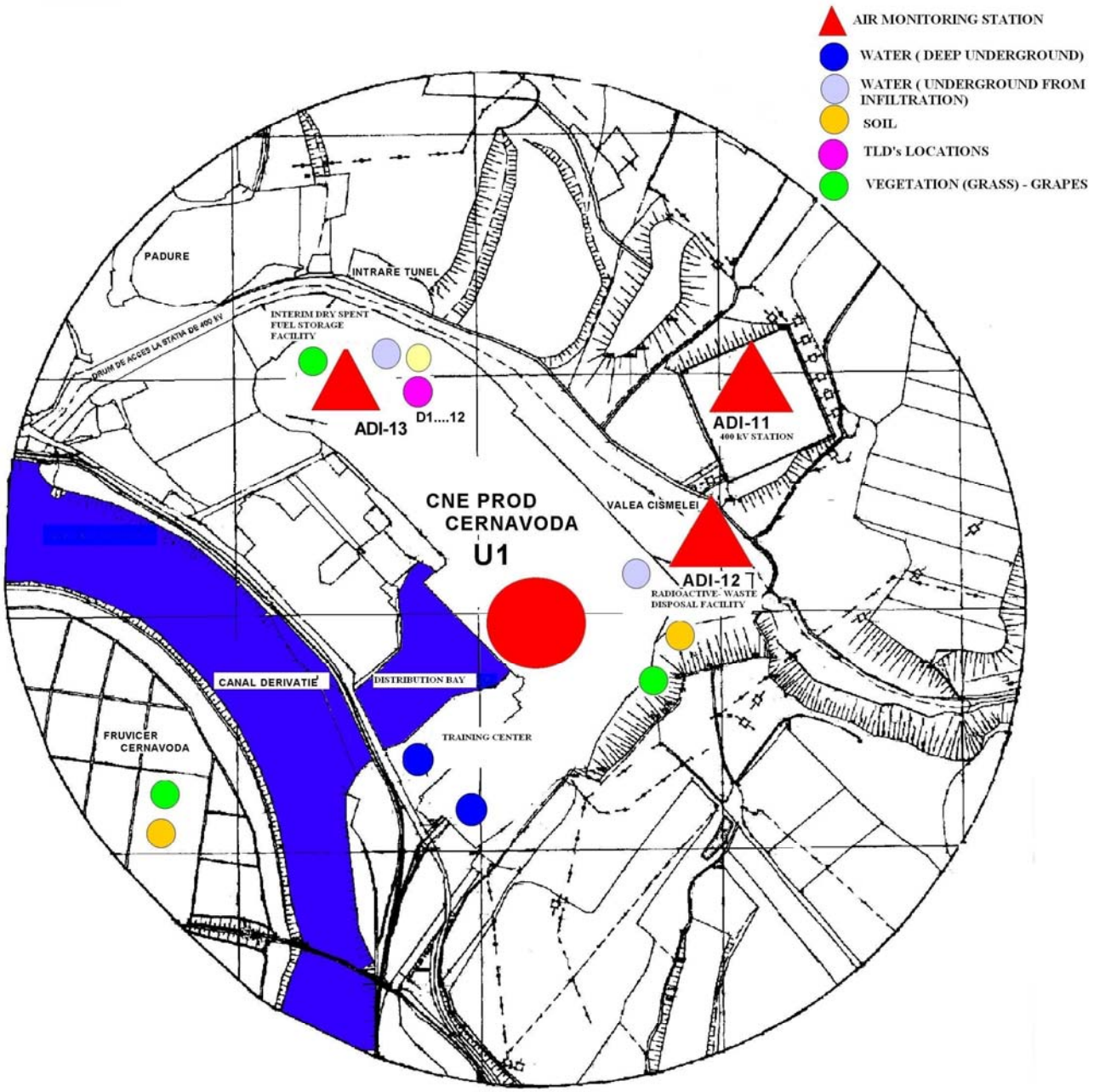
APPENDIX 5

NPP CERNAVODĂ - ENVIRONMENTAL MONITORING PROGRAMME (details)

Nuclide	Half life (T1/2)	Environmental media	Monitoring frequency
Tritium	12.3 years	air	continuous
		vegetables - fruit	quarterly
		milk	weekly
		water	daily
Noble gases	days	air	continuous
I-131	8 days	air	continuous
		milk	weekly
Cs-134	2 years	milk	weekly
		air	continuous
		soil	twice in a warm season
		drinking water	daily
		fish	quarterly
gross ß	"60 years"	water	daily
		milk	weekly
		soil	twice in a warm season
		fish	quarterly
		air	continuous
C-14	5730 years	milk	weekly
		vegetables - fruits	quarterly
		animal produce	annual
		drinking water	daily

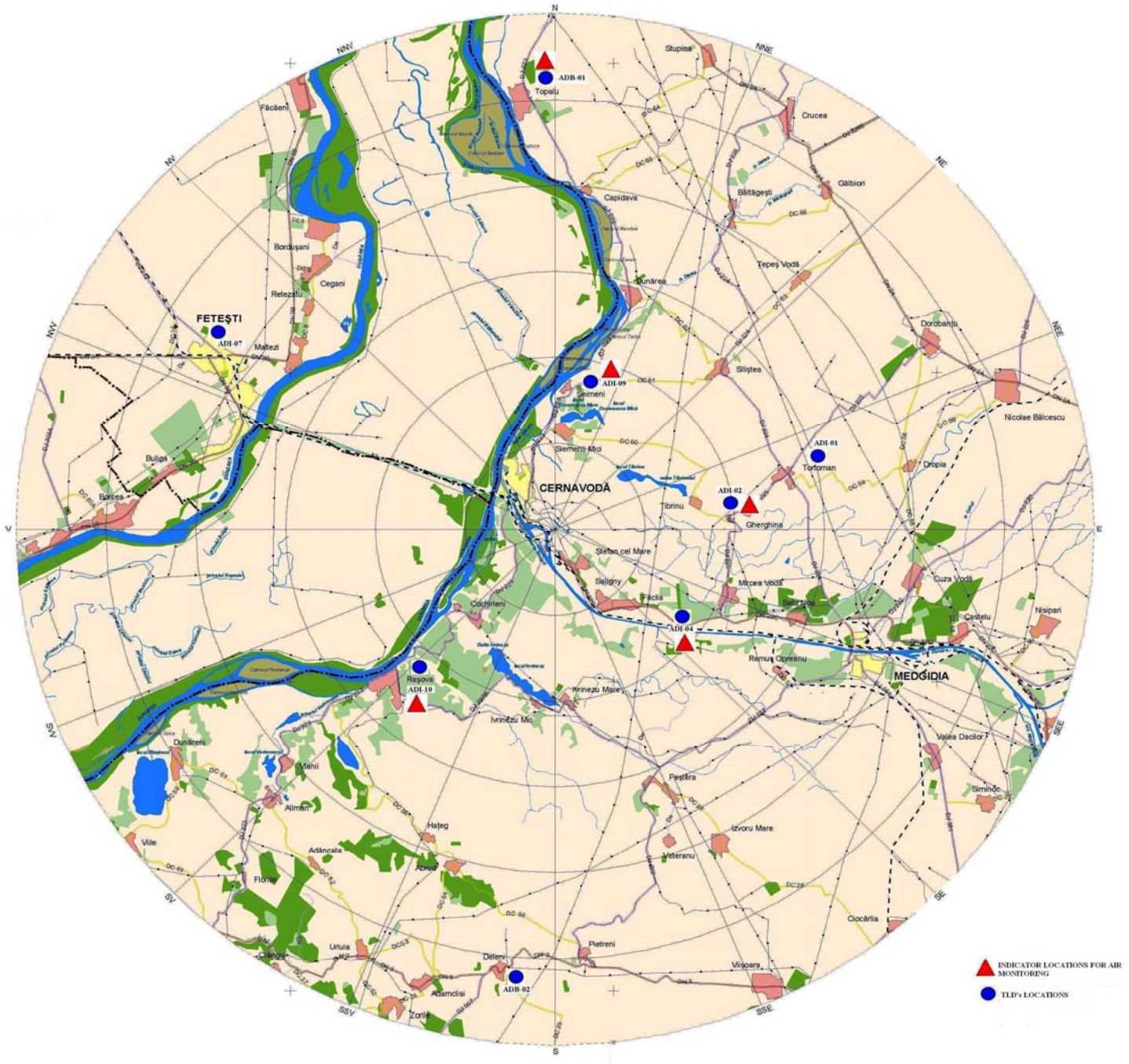
APPENDIX 6

NPP CERNAVODĂ - ON-SITE ENVIRONMENTAL MONITORING LOCATIONS



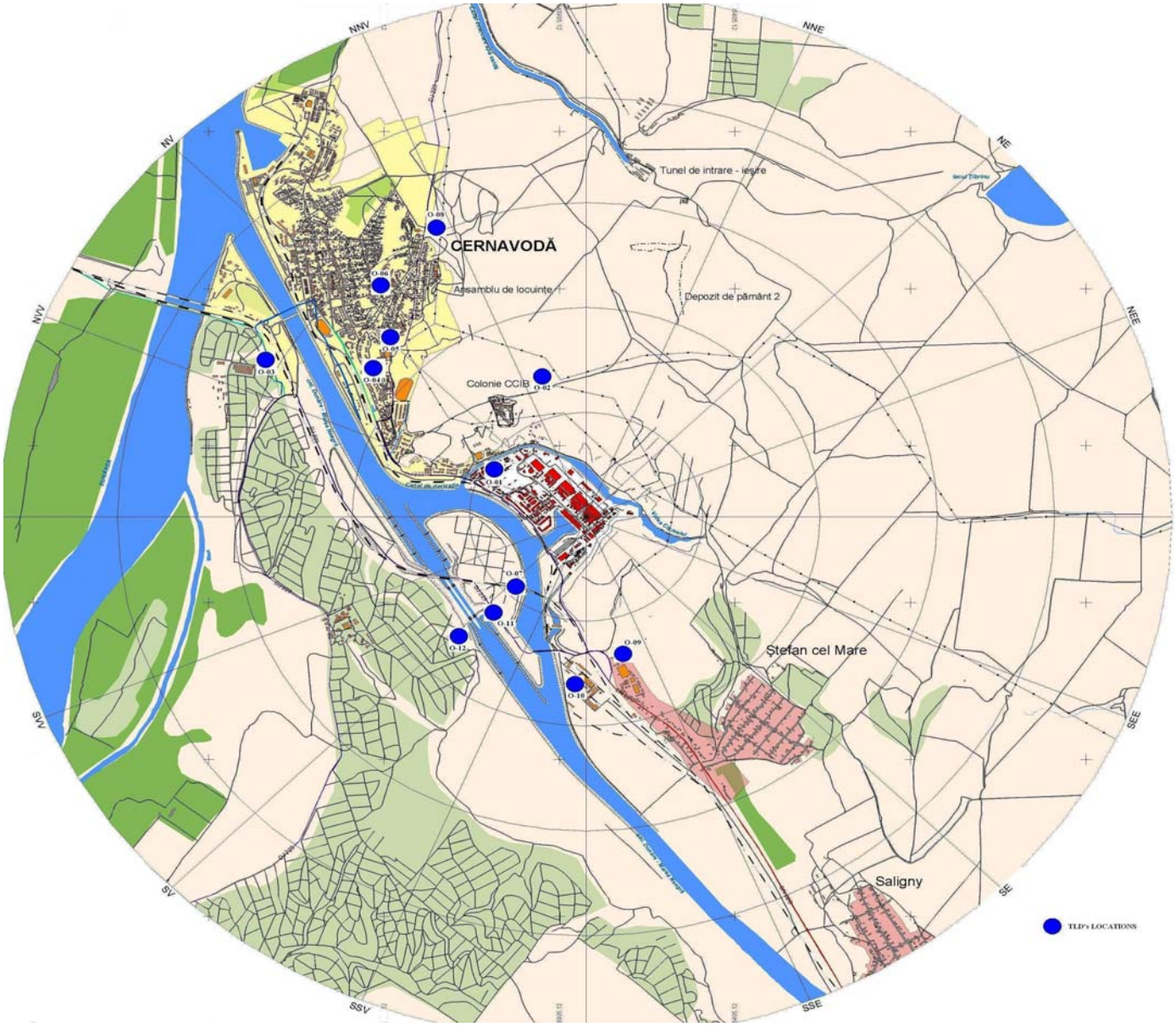
APPENDIX 7

NPP CERNAVODĂ - OFF-SITE MONITORING LOCATIONS (air and TLD)



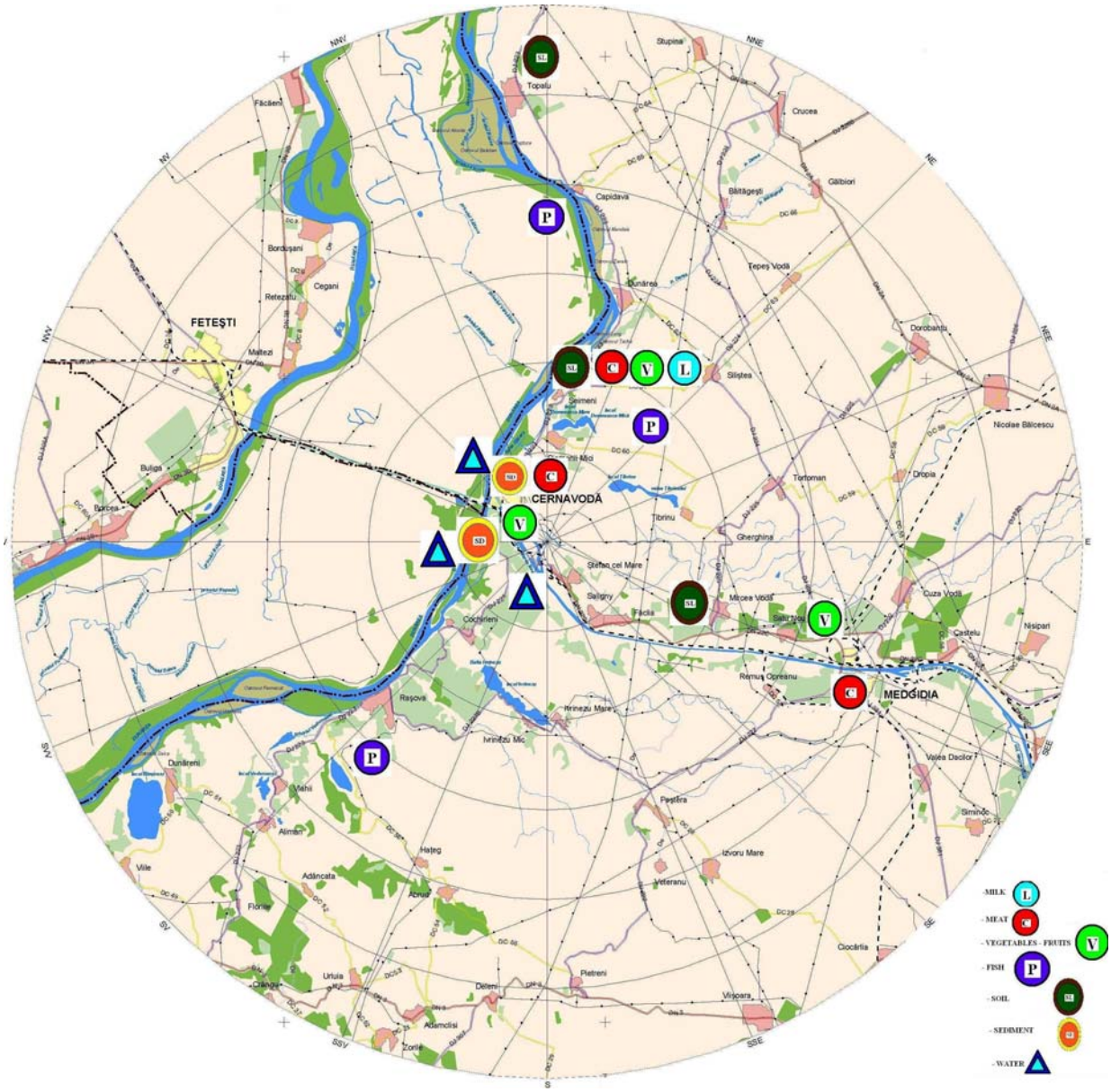
APPENDIX 8

NPP CERNAVODĂ – OFF-SITE MONITORING LOCATIONS (TLD locations near Cernavodă Town)



APPENDIX 9

NPP CERNAVODĂ – OFF-SITE MONITORING LOCATIONS (except air and TLD)



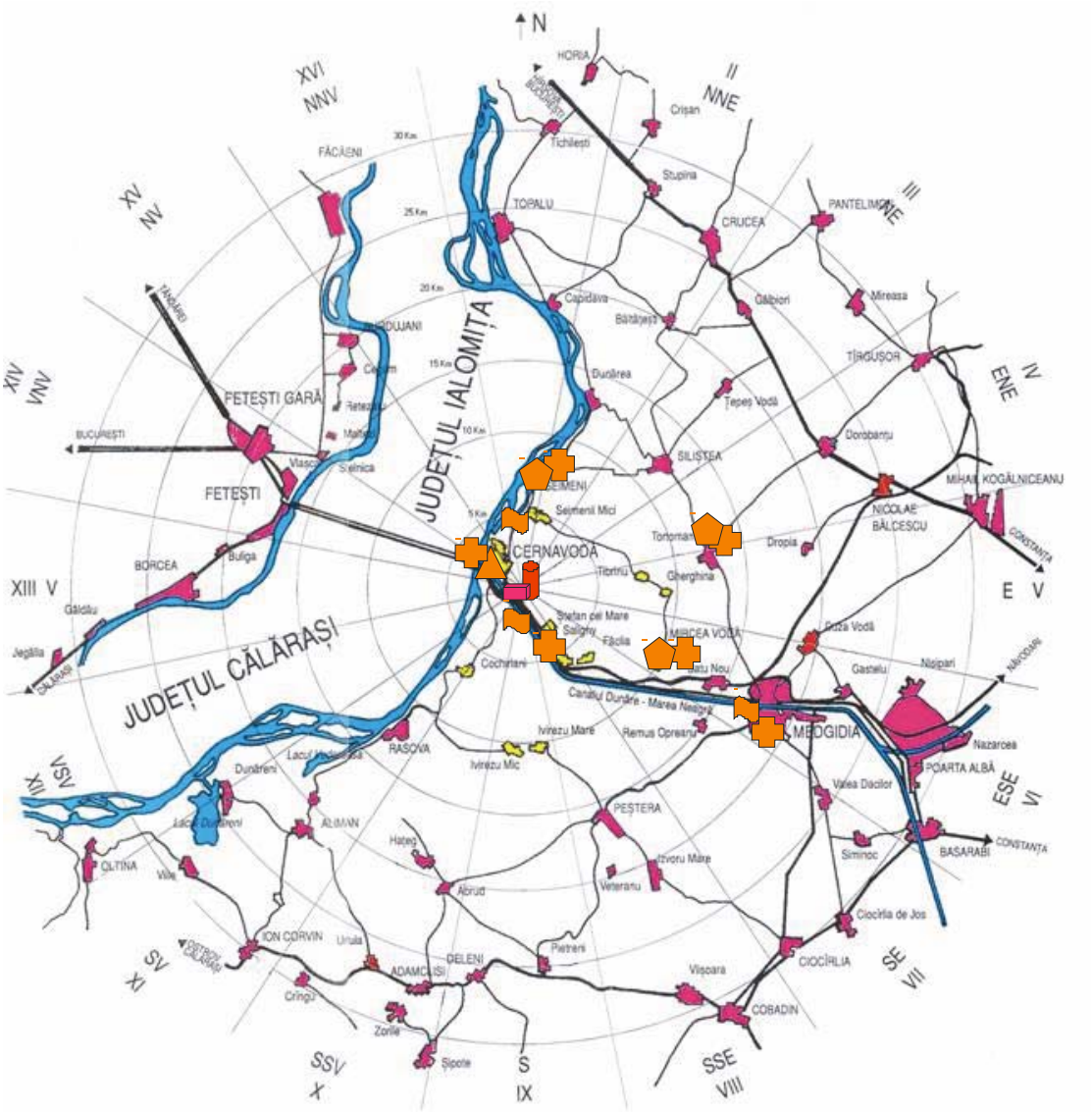
APPENDIX 10

OVERALL DESCRIPTION OF CNCAN RADIOACTIVITY MONITORING AND CONTROL PROGRAMME

Sample type	Sampling location	Sampling frequency	Collected quantity	Type of analysis*	Measurement frequency
Air	Cernavodă	Periods of 72 hours	~100 cm^3 min^{-1}	HTO, HT, C-14 (LSC)	Monthly
Precipitations	Cernavodă	During precipitation time intervals	0.5 liter	HTO (LSC)	Monthly
Surface water	Seimeni Channel Seimeni Danube–Black Sea Channel Medgidia	Monthly	0.5 liter 12 liters	HTO (LSC) Gamma spectr.	Monthly
Vegetation (grass)	Cernavodă Saligny Seimeni Mircea Voda Tortomanu Medgidia	Bi-annually	Vegetation on a surface of 0.5 m^2 Vegetation on a surface of 1 m^2	HTO (LSC) Gamma spectr.	Bi-annually
Soil	Cernavodă Saligny Seimeni Mircea Voda Tortomanu Medgidia	Bi-annually	Surface soil of 10 x 10 x 5 cm^3 Surface soil of 10 x 10 x 5 cm^3	HTO (LSC) Gamma spectr.	Bi-annually
Agriculture soil	Seimeni Mircea Voda Tortomanu	Annually	Surface soil of 10 x 10 x 5 cm^3 Surface soil of 10 x 10 x 5 cm^3	HTO (LSC) Gamma spectr.	Annually
Milk	Seimeni Mircea Voda Tortomanu	Monthly	0.5 liter 0.5 liter	HTO (LSC) Gamma spectr.	Monthly
Vegetables & fruits	Seimeni Mircea Voda Tortomanu	Annually	1 kg fresh weight 1 kg fresh weight	HTO (LSC) Gamma spectr.	Annually

APPENDIX 11

CNCAN SAMPLING LOCATIONS



- air, precipitation
- milk, agriculture soil, vegetables & fruits
- surface water
- vegetation (grass), soil