EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D - Nuclear Safety and Fuel Cycle
Radiation protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

SWEDEN

13-16 November 2012

Reference: SE-12/08

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES: Central Interim Storage Facility (CLAB)

Environmental radioactivity monitoring in the vicinity of the Oskarshamn site

National environmental radioactivity monitoring network

LOCATIONS: Stockholm and Oskarshamn

DATES: 13-16 November 2012

REFERENCE: SE-12/08

INSPECTORS: Mr V. Tanner (team leader)

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DATE OF REPORT: 6 September 2013

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TECHNICAL REPORT

ABBREVIATIONS

BAT	Best Available Technology
BSS	Basic Safety Standards
CLAB	Central Interim Storage Facility for Spent Nuclear Fuel
DG ENER	Directorate-General for Energy
EC	European Commission
EURDEP	European Radiological Data Exchange Platform
FKA	Swedish Defence Research Agency
FOI	National Defence Research Agency
FWHM	Full Width at Half Maximum
GM	Geiger-Müller (radiation detector)
HELCOM MORS	Helsinki Commission – Monitoring Of Radioactive Substances
HEPA	High Efficiency Particulate
HPGe	High Purity Germanium (gamma radiation detector)
IAEA	International Atomic Energy Agency
MCA	Multichannel Analyser
MDA	Minimum Detectable Activity
NFA	National Food Administration
NIST	National Institute of Standards and Technology
OSART	Operational Safety Review Team
QA	Quality Assurance
SGU	Swedish Geological Survey
SKB	Swedish Nuclear Fuel and Waste Management Co
SLV	Livsmedelsverket (National Food Agency)
SMHI	Swedish Meteorological and Hydrological Institute
SSM	Swedish Radiation Safety Authority
WANO	The World Association of Nuclear Operators

1 INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State shall establish the 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. The Radiation Protection Unit (ENER D.3) of the EC's Directorate-General for Energy (DG ENER) 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.

Taking into account previous bilateral protocols, a Commission Communication[2] was published in the Official Journal on 4 July 2006 describing practical arrangements for the conduct of Article 35 verification visits in Member States.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The EC's decision to conduct of an Article 35 verification was notified by letter dated 2 February 2012 addressed to the Swedish Permanent Representation to the European Union. The Swedish Government subsequently designated the Swedish Radiation Safety Authority to lead the preparations for this visit.

2.2 DOCUMENTS

In order to facilitate the work of the verification team, a package of information was supplied in advance by the Swedish authorities. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 1 to this report. The information thus provided has been extensively used for drawing up the descriptive sections of the report.

2.3 PROGRAMME OF THE VISIT

The EC and the Swedish Radiation Safety Authority discussed and agreed upon a programme of verification activities, with due respect to the Commission Communication of 4 July 2006 setting out practical arrangements for the conduct of Article 35 verification visits.

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

2 Commission Communication "Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty. Practical arrangements for the conduct of verification visits in Member States". (OJ C 155, 4.7.2006, p. 2–5)

During the opening meeting presentations were given on the following topics:

- Overview of the work of the Swedish Radiation Safety Authority
- Swedish Radiation Safety Authority Radio-analytical laboratory
- Discharge and environmental monitoring in Sweden
- National environmental radioactivity monitoring network

At a subsequent meeting in Oskarshamn the following subjects were presented:

- SKB chemistry laboratory
- Interim Storage Facility for Spent Nuclear Fuel (CLAB)

The verification team notes the quality and comprehensiveness of all presentations made and documentation provided.

The verifications were carried out in accordance with the programme in Appendix 2.

3 REPRESENTATIVES OF THE SWEDISH COMPETENT AUTHORITIES AND OTHER ENTITIES

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

Swedish Radiation Safety Authority (SSM)

Johan Friberg	Head of Department of Radiation Protection	Department of Radiation Protection
Lennart Carlsson	Head of Department of Nuclear Power Plant Safety	Department of Nuclear Power Plant Safety
Lynn Hubbard	Head of Section, Emergency Preparedness	Department of Radiation Protection
Helene Asp	Head of Section, Environmental Assessment	Department of Radiation Protection
Jan Lillhök	Head of Section, Facility Radiation Protection	Department of Nuclear Power Plant Safety
Pål Andersson	Senior Analyst, Environmental Assessment	Department of Radiation Protection
Ann-Christin Hägg	Senior Analyst, Radiation Protection and Discharges	Department of Nuclear Power Plant Safety
Maria Lüning	Senior Analyst, Environmental surveillance	Department of Nuclear Power Plant Safety
Elisabeth Höge	Site Inspector, CLAB	Department of Radioactive Materials
Lilian del Risco Norrlid	Senior Analyst, Radio analytical Laboratory	Department of Radiation Protection
Jan Johansson	Senior Analyst, Emergency Preparedness	Department of Radiation Protection
Inger Östergren	Laboratory engineer	Department of Radiation Protection
Sara Ehrs	Laboratory engineer	Department of Radiation Protection

SKB and OKG

Ingvor Svantesson	Radiation Protection Supervisor	SKB , Department of Nuclear Safety
Paul Arvidsson	Specialist in Radiochemistry	OKG/GK, Department of Chemistry
Johan Leijon	Deputy Chemistry Manager	OKG/GK, Department of Chemistry
Patrick Miss	Chemist Environmental Surveillance	OKG/GK, Department of Chemistry
Irené Boren	Process Chemist	SKB/TDK, Department of Technology, Chemistry
Ann-Sofie Karlsson	Manager Chemical Department	SKB TDK, Department of Technology, Chemistry
Marcus Nilzén	Site Manager CLAB	SKB/DC, Department of Operations, CLAB
Stig-Åke Nilsson	Deputy Operation Manager	SKB/DCD, Department of Operations, CLAB operation
Benny Jonsson	Deputy Section Manager, Chemistry and radioactive waste	SKB/DCDS, Department of Operations, CLAB operation support

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

4 COMPETENT AUTHORITIES & LEGAL BACKGROUND

4.1 INTRODUCTION

The **Swedish Radiation Safety Authority SSM** is a managing authority under the Ministry of the Environment since 1 July 2008, with national collective responsibility within the areas of radiation protection and nuclear safety. The authority took over the responsibility and tasks from the Swedish Radiation Protection Authority (SSI) and the Swedish Nuclear Power Inspectorate (SKI) when these ceased to exist on 30 June 2008. SSM is therefore the competent authority according to the Radiation Protection Act (SFS 1988:220) and the Nuclear Activities Act (SFS 1984:3). The Swedish parliament has appointed the SSM to implement its environmental quality objective *Säker Strålmiljö* (A Safe Radiation Environment).

According to the Radiation Protection Ordinance (SFS 1988:293) the SSM has the mandate to issue regulations in the field of radiation protection including environmental and discharge control. The Swedish environmental radioactivity monitoring program consists of local monitoring programs in the vicinity of nuclear facilities as well as long-term environmental monitoring of radiation throughout Sweden. The SSM continuously monitors the gamma dose rate in Sweden with a system of 32 statutory gamma measurement stations.

Special provisions for the environmental monitoring in the vicinity of nuclear facilities are given in the SSM Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities (SSMFS 2008:23). The environmental monitoring program was issued by the SSI (latest version, SSI report 2004:15, 1 January 2005) and is still valid.

The **National Food Administration NFA** is the central supervisory authority for matters relating to food. The NFA has the task of protecting the interests of the consumer by working for safe food of good quality, fair practices in the food trade, and healthy eating habits. The responsibility of the NFA also includes radioactive contaminants in food.

4.2 LEGAL PROVISIONS FOR ENVIRONMENTAL RADIOACTIVITY MONITORING

The basis for environmental radioactivity monitoring is the Radiation Protection Act (SFS 1988:220), which aims to protect people, animals and the environment from the harmful effects of radiation, and the Environmental Code (SFS 1998:808), which addresses environmental aspects of nuclear activities and lists "nuclear activities" among several other "environmentally hazardous activities". The provisions of the Radiation Protection Act and the Environmental Code supply the general principles of the regulatory regime. These acts are supplemented by a number of ordinances and other secondary legislation containing more detailed provisions for environmental radioactivity monitoring.

In accordance with the Radiation Protection Ordinance (SFS 1988:293) the Swedish Radiation Safety Authority has issued a number of regulations implementing the EU Council Directive 96/29/EURATOM.

4.2.1 Legislative acts regulating environmental radioactivity monitoring

The following are the main legal acts on environmental radioactivity monitoring in Sweden:

- The Swedish Radiation Safety Authority's Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities (SSMFS 2008:23)

- Environmental Control Program (SSI Report 2004:15)
- Swedish Environmental Objectives: Partial Objectives and Action Strategies (Regeringens proposition 2000/01:130) including guidelines for the implementation of A Safe Radiation Environment
- EU Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption
- EU Council Directive 96/29/Euratom laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation

4.2.2 Legislative acts regulating radiological surveillance of foodstuffs

The following are the main legal acts on radiological surveillance of foodstuffs:

- Swedish Food Regulation, Food Act (SFS 2006:804)
- Swedish Food Regulation, Food Decree (SFS 2006:813)
- The National food Administration's Regulations (LIVSFS 1993:36) on certain foreign substances in food
- The National Food Administration's Regulations (SLVFS 2004:7) on amendments of the National food Administration's Regulations (LIVSFS 1993:36) on certain foreign substances in food

4.2.3 Legislative acts regulating discharge monitoring

The following is the main legal act on discharge monitoring:

- The Swedish Radiation Safety Authority's Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities (SSMFS 2008:23)

4.3 GUIDANCE DOCUMENTS

In addition to legally binding texts, the following guidance documents are used in environmental radioactivity monitoring:

- EU recommendation 2000/473/Euratom
- ICRP publications 60, 101 and 103
- IAEA Safety Standard WS-G-2.3 Regulatory Control of Radioactive discharges to the environment
- IAEA Safety Standards series No. GSR Part 3 (Interim), Radiation Protection and Safety of Radiation Sources, International Basic Safety Standards, 2011
- MARINA 2, Pilot Study for the update of the MARINA Project on the radiological exposure of the European Community from radioactivity in North European marine waters
- HELCOM recommendation 26/3

- OSPAR Convention and the OSPAR strategy
- OSPAR, Agreement on North-East Atlantic Environment Strategy (2010-3)
- OSPAR, Decision on substantial reductions and elimination of discharges, emissions and losses of radioactive substances (200/1)
- OSPAR, Program for the more detailed implementation of the OSPAR strategy with regard to radioactive substances (2001-3)
- OSPAR, Agreement on monitoring program for concentrations of radioactive substances in the marine environment (2005-8)
- OSPAR, Agreed reporting procedure for discharges from non-nuclear sector (2005-7)
- OSPAR, Reporting formats for the collection of data on liquid discharges from nuclear installations (1996-02)
- OSPAR, Joint assessment and monitoring program 2010-2014 (2010-4)
- 1991 UN/ECE Espoo Convention on Environmental Impact Assessment in a trans boundary context and its protocol on Strategic Environmental Assessment (Kiev, 2003)

5 THE CLAB FACILITY AND ITS RADIOLOGICAL SURVEILLANCE PROGRAM

5.1 GENERAL DESCRIPTION OF THE SITE

The central interim storage facility for spent nuclear fuel, CLAB, is situated on the south east coast about 30 km north of Oskarshamn municipality in Kalmar County. It is situated on the coastline of the Baltic Sea and uses sea water for cooling.

CLAB started operation in 1985 with one storage hall; a second hall has been in operation since 2008. It consists of 2 rock caverns with 8 storage ponds situated 40m below the surface. Storage capacity is 8000t U; annual arrivals are approximately 200t U.

Since 1977, the Swedish nuclear power industry has been required by law to manage the radioactive nuclear fuel and the waste from the Swedish nuclear power plants and to finance these activities. On behalf of the owners of the nuclear power plants, SKB - Svensk Kärnbränslehantering AB (the Swedish Nuclear Fuel and Waste Management Company) - is responsible for the final disposal of spent nuclear fuel and radioactive waste (except for the Very Low-Level Waste). SKB is thereby a stakeholder-owned company that performs most of its services on behalf of its owners. A final repository for short-lived low and intermediate waste (SFR) and a central interim storage facility for spent nuclear fuel (CLAB) have been in operation since the mid-1980s. These two nuclear facilities are operated under SKB's auspices. The company's mission will be complete when all radioactive nuclear fuel and waste has been placed in final repositories in such a manner that no further measures are required for long-term safety.

SKB takes responsibility for spent nuclear fuel and radioactive waste from the time it leaves the nuclear power plants. This means that SKB is responsible for transport, interim storage and final disposal of spent nuclear fuel and radioactive waste.

SKB operates a whole transportation system that carries out safe transportation of the radioactive waste and spent nuclear fuel from the nuclear power plants to SKB's facilities. Since all Swedish nuclear power plants are located along the coast, the shipments go by sea on the vessel M/S Sigyn. A new vessel, Sigrid, will replace Sigyn during 2013.

SKB History

1973 SKB is formed by the nuclear power producers and starts operation.

1985 CLAB is commissioned.

1988 SFR is commissioned.

2007 SKB takes over operation of the central interim storage of spent nuclear fuel (CLAB). (Operation of CLAB was previously subcontracted by SKB to OKG.)

2008 The extension of CLAB, CLAB2, is put into operation.

2009 SKB takes over operation of the repository for short-lived radioactive waste at Forsmark (SFR). Operation of SFR was previously subcontracted by SKB to FKA.

2010 Selection of Forsmark as the site of the future deep rock repository for spent fuel.

2011 Applications for construction of a deep rock repository and an encapsulation plant for spent fuel are submitted to the authorities.

5.2 Regulation of discharges

5.2.1 Introduction

On the basis of the authorisation granted in the Radiation Protection Ordinance the SSM has issued Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities, SSM FS 2008:23, (originally issued 1st January 2002 in SSI FS 2000:12).

These regulations apply to the following nuclear facilities for which the Government has granted licences under the Nuclear Activities Act (1984:3):

1. Nuclear power reactors
2. Reactors for research or materials testing
3. Plants for manufacturing of uranium pellets and nuclear fuel bundles
4. Facilities for storage or other handling of used nuclear fuel
5. Facilities for storage, treatment or final disposal of nuclear substances or nuclear waste

The regulations apply to all discharges of radioactive substances from nuclear facilities that are directly related to normal operating conditions at the respective facility. The regulations do not apply to:

1. Shallow land burial of low activity nuclear waste
2. Transports of nuclear substances or nuclear waste outside the operating area of a facility
3. Dismantling of nuclear facilities
4. The conditions following sealing of a waste facility

The limitation of discharges of radioactive substances from nuclear facilities shall be based upon optimisation of radiation protection while using the best available technique (BAT). Such optimisation of radiation protection includes all facilities located within the same geographical area. The possibility that the limitation of discharges to the environment may imply that radiation doses to the personnel will be increased is taken into account during optimisation, as well as the consequences of other waste management.

In the regulations, best available technique is defined as "the use of the most effective method to limit the discharge of radioactive substances and their harmful effects on human health and the environment, and which does not give rise to unreasonable costs ".

A service agreement between SKB and OKG regulates cooperation and conditions for the facilities in the same geographic area, including discharges and BAT for analysis. This agreement is followed-up in regular meetings with the Radiation Protection Supervisors from SKB and OKG.

5.2.2 Dose limits for nuclear facilities

The dose limit for individuals of the general public, resulting from all practices, is 1 mSv annual effective dose. This is a requirement in the EU BSS, but the limit has been in use in Sweden since 1990, following the entry into force of regulations on dose limits in practices involving ionising radiation etc. (latest version SSM FS 2008:51).

According to the regulation SSMFS 2008:23 the effective dose to an individual in the critical group, from one year of releases of radioactive substances to air and water from all facilities located in the same geographically delimited area, shall not exceed 0.1 mSv. The effective dose, which concerns the dose from external radiation and the committed effective dose from internal radiation, shall be aggregated over a period of 50 years.

When calculating the dose to individuals in the critical group, both children and adults shall be taken into consideration. Dose coefficients that are to be used for intake and inhalation are specified in Appendix III of the European Council Directive 96/29/Euratom.

When the calculated dose is 0.01 mSv or more per calendar year, realistic calculations of radiation doses shall be conducted for the most affected area. The calculations shall be based on measured dispersion data and knowledge of the conditions for the period concerned.

5.2.3 Discharge limits

SSM has not defined any radionuclide specific discharge limits. Limitation of releases is based on the restriction of dose to the critical group members. For each nuclear facility, CLAB in this case and for each radionuclide that may be released, specific release-to-dose factors (mSv/Bq) are calculated. The factors are calculated for hypothetical critical groups, and take into consideration local dispersion conditions in air and in the environment, local settlements, locally produced foodstuffs as well as moderately conservative assumptions on diet and the contribution of locally produced foodstuffs to the diet of the group. The latest revision of release-to-dose factors are based on more realistic assumptions than earlier and in line with the requirements in the EU BSS.

For nuclear facilities, release-to-dose factors have been calculated for radionuclides that may be discharged to the marine environment and radionuclides that may be emitted to air. The dose contributions from all monitored radionuclides released are summed up, and this sum must not exceed 0.1 mSv for a calendar year.

5.2.4 Release monitoring requirements

Discharges of radioactive substances from a nuclear facility into air and water are checked by means of measurements. The detection levels of the instruments are chosen to afford comparison with the values for the effective dose to an individual and the reference value for a particular nuclear facility.

Releases into the air are checked by means of nuclide-specific measurements of continuously collected samples of particle-bound radioactive substances and, when applicable, of Iodine and Tritium. At CLAB it is not applicable to measure iodine or tritium in releases to the air.

Discharges into water are checked by means of measurements of representative samples for each discharge path. The analyses include nuclide-specific measurements of gamma- and alpha-emitting radioactive substances and, when applicable, of Strontium-90 and Tritium.

Representative monthly samples of discharges into water from nuclear power reactors, and reactors for research or materials testing are sent to the Swedish Radiation Safety Authority within two months after the end of the month concerned. Representative yearly samples are sent to the Swedish Radiation Safety Authority within three months after the end of the year concerned.

CLAB is not considered a nuclear facility in the sense of a nuclear power reactor, but the SSM annually requests physical samples of discharge water from the facility.

The industry is required to have an implemented system for the control and maintenance of the measuring equipment and the release limiting systems. Important malfunctions should be reported to the authority. If the measuring system has to be out of order for longer time periods a special permit from the SSM is needed.

Diffuse leakages of radioactive substances should also be estimated and reported to SSM according to SSMFS 2008:23.

5.2.5 Reporting

The licensees, SKB in this case, report nuclide specific releases to the SSM twice a year. The second report, which is an annual report, contains dose to a representative person in the critical group, detection limits, measuring methods, deviations in the monitoring systems, unplanned releases of radioactive substances and estimates of diffuse releases in accordance with SSMFS 2008:23.

5.3 STATUTORY DISCHARGE MONITORING PROGRAM

5.3.1 Introduction

The executive manager of SKB has the main responsibility for the fulfilment of the demands in laws and regulations. It is the responsibility of the operation management to ensure that the discharges of radioactive substances are consistent with the authorities' demands and CLABs goals and policies. The partition of responsibilities between the operative organisation (DC) and the chemistry department (TDK) is regulated in the order from DC to TDK and also in routines and instructions.

Discharges of radioactive substances are only allowed at points where conversion factors between released activity and dose to a representative person are established. The table below summarises the discharge monitoring at the CLAB facility.

Sample type	Sampling point	Assignment	Sampling	Sampling interval	Analysis	Analysed material	Responsible
Air discharge	Main stack	553CB11	Particles	Weekly	total α	Aerosol filter	SKB, CLAB
Air discharge	Main stack	553KB711	Noble gases	On-line	β	Air	SKB, CLAB
Air discharge	Main stack	553CB11	Particles	Every 2nd week	α (nuclide specific)	Batch of six aerosol filters per quarter	OKG
Air discharge	Main stack	553CB11	Particles	Every 2nd week	Sr-90	Batch of six aerosol filters	Studsvik Nuclear
Water discharge	Waste water tank outlet	375TA11 375TB11	Water	Sampling during release	γ, H-3, total α	Analysis of a batch sample collected during a month	SKB, CLAB

Sample type	Sampling point	Assignment	Sampling	Sampling interval	Analysis	Analysed material	Responsible
Water discharge	Waste water tank outlet	375TA11 375TB11	Water	Sampling during release	α (nuclide specific)	Analysis of a batch sample collected during a month	OKG
Water discharge	Waste water tank outlet	375TA11 375TB11	Water	Sampling during release	Sr-90	Analysis each quarter of a 1 litre sample from the three month batch sample	OKG

5.3.2 Aerial discharges

The release point for air from the controlled area is the main stack which is controlled by on-line measurements of β activity in the air and continuous capture of airborne particles on aerosol filters. The aerosol filters are changed every week and analysed for gamma emitting nuclides and total α. The filters are also used for analysis of Sr-90 and nuclide specific-α.

5.3.3 Liquid discharges

Water discharges are released into the cooling water outlet from CLAB. Radioactive waste water is stored in two large release tanks (375TA11 and 375TB11) before release to the environment. The water is released through system 713, which is connected to the cooling channel for the Oskarshamm 1 and 2 nuclear power plants . The cooling channel ends up in the Hamnefjärden which is a part of the Baltic Sea. Prior to the release a non-statutory pre-sample is taken and measured to control that the radioactivity in the water in the release tanks is sufficiently low on gamma emitting nuclides.

During discharge a proportional part of the released water is collected in a sampling tank (375 TB21). Eight litres are taken from the sampling tank for each batch released. Four litres are used for preparing the monthly batch sample and the remaining water is stored. The monthly sample is used for nuclide specific alpha and gamma analysis and H-3 and Sr-90 analysis. Normally two monthly water samples per year are sent to the SSM.

5.4 STATUTORY ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAM

5.4.1 Introduction

The regulations (SSMFS 2008:23) include provisions on environmental monitoring. The environmental monitoring program is issued by the SSM (latest version, SSI report 2004:15, valid from 1st of January 2005). It specifies type of sampling, sample treatment, radionuclides to be measured, reporting, etc. The monitoring program is divided into a terrestrial and an aquatic part. The selection of environmental samples (biota and sediments) has been conducted in order to be highly representative of the area around the facility and preferably to be similar (or have a similar function in the ecosystem) for all facilities. Species which are part of the human food chain are also selected. Every year a base program involving spring and autumn sampling is conducted. Furthermore, certain samples are taken on a monthly and quarterly basis. In addition to the base program, extended sampling is conducted every fourth year. The extended program focuses exclusively on samples taken in the marine environment.

The Swedish University of Agricultural Sciences (SLU) conducts the sampling of environmental samples outside the facilities. The samples are analysed by the facilities themselves or at an external laboratory. The laboratory has to have an adequate system for quality assurance. To verify that the facilities comply with the program, SSM conducts inspections and takes random sub-samples for measurements at the SSM or at independent laboratories. The environmental samples consist of local flora and fauna e.g. algae, fish, shellfish, mosses, game and sediment as well as local food products (grain, milk etc.).

The environmental surveillance program determines the impact to the environment by monitoring dose rates and the concentration of radionuclides in water and on the ground. The program also provides reassurance that discharges are estimated correctly and that unusual discharges to the environment are recognized early.

5.4.2 Environmental surveillance program at OKG/CLAB

At Simpevarp peninsula OKG operates the Oskarshamn NPP with three boiling water reactors and SKB operates the intermediate storage of spent fuel, CLAB. The environmental surveillance program is combined for OKG and CLAB.

The main recipient for the discharge from Simpevarp is the Baltic Sea; therefore the marine environment is thoroughly monitored with samples from various water living organisms from a large number of sampling stations. There are in total 30 sampling stations within a radius of 98 km from Simpevarp.

The land environment is also closely monitored; soil, vegetation and sludge are sampled as well as human foodstuffs such as milk and meat, vegetables and grain. There are six sampling stations for the land environment (excluding dosimeter stations), all within 27 km from the plant. All samples are measured for nuclide specific activity but also with regard to weight and appearance to determine if any effects on growth and reproducibility occur.

The OKG/CLAB environmental surveillance program consists of two parts: an annual base program and an extended program in the marine environment performed every four years. The base program makes it possible to detect short-term trends and covers a larger geographic area. The tables below summarize the content of the two programs. Replacement species are to be used when the ordinary species are hard to find in sufficient amount for collecting a sample. The replacement species are also decided on by them SSM. The locations of the sample stations are given in Figure 1.

Water environment, base program

Sample type	Number of stations	Frequency	Number of sample types	Number of samples / year
Diatomic algae	2	Monthly	1	24
Sediment	2	Quarterly/(autumn)	1	5
Algae	7	Autumn	1	7
Molluscs	5	Autumn	3	5

Water environment, extended program

Sample type	Number of stations	Frequency	Number of sample types	Number of samples / four years
Sediment		Every four years	1	13
Algae	9	Every four years	2	10
Molluscs	7	Every four years	3	8

Land environment

Sample type	Number of stations	Frequency	Number of sample types	Number of samples / four years
Natural vegetation	4	Spring/ Autumn	3	14
Cultivated vegetation	2	July+ Autumn	5	6
Animal samples	1	Autumn	1	1
Milk	1	Each fortnight (pasture season)	1	10-14
Sludge	2	Autumn	1	2
Dose measurements (TLD)	10	Quarterly	1	40

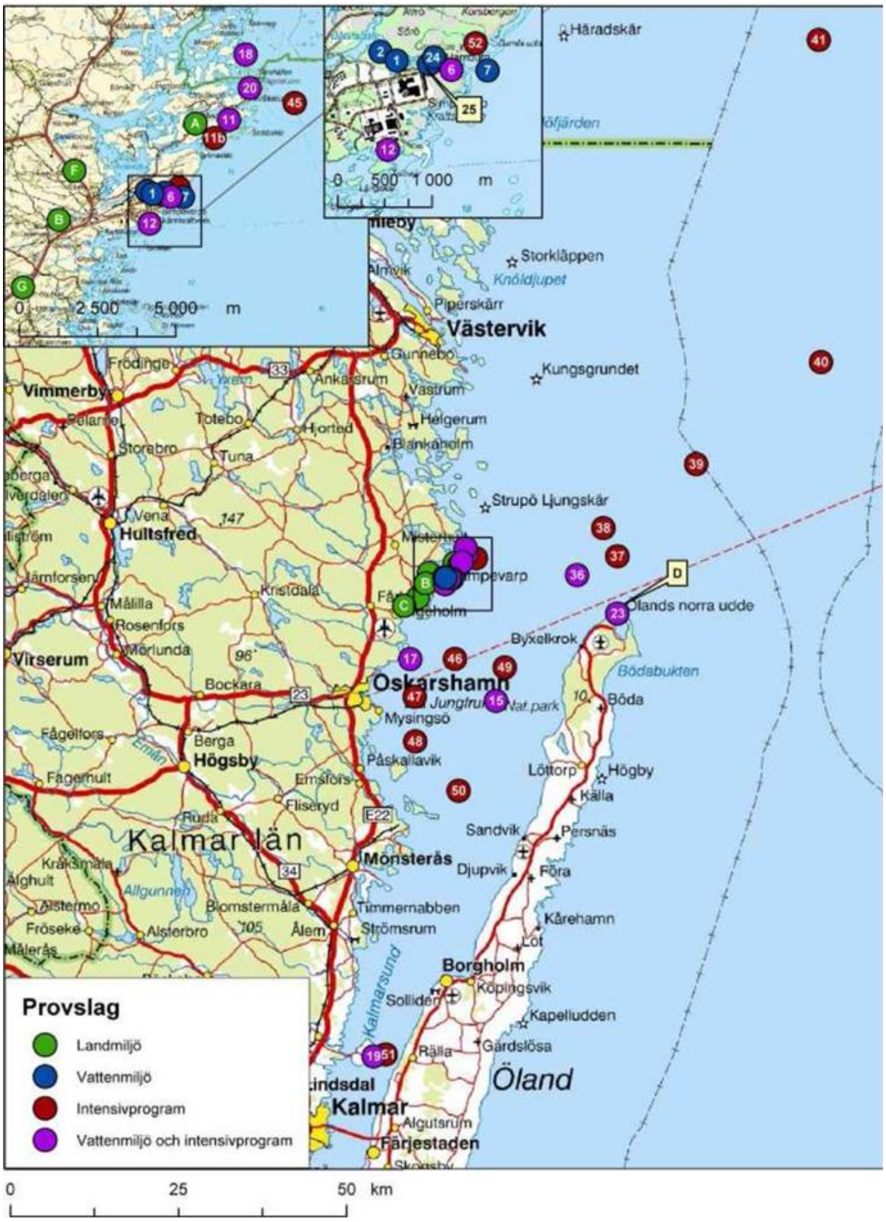

Figure 1. Location of sampling stations of the OKG/CLAB environmental monitoring programme

The SLU delivers most of the samples but staff from OKG picks up the milk samples at a nearby farm. Double samples on several sample types are gathered and sent to the SSM for independent analysis.

All radioactivity measurements are performed on dry materials. Some samples are burnt into ashes in ovens and thereafter measured in established geometries on germanium detectors in the environmental sample laboratory. Detection limits for Cr-51, Mn-54, Fe-59, Co-58, Co-60, Zn-65, Nb-95, Ag-110m, Sn-113, I-131 (milk), Cs-134 and Cs-137 are determined and reported to the SSM in the annual report.

5.4.3 Dosimeters and dose rate measurements in the surroundings

As CLAB and OKGs NPPs are located together the description of the measurement system in the surroundings is for the site as a whole, even if the requirements in the regulations formally are for the NPPs.

Ten TLD700 thermoluminescent dosimeters (TLDs) are placed within a radius of about one km from the combined CLAB/OKG-plant. These are changed and evaluated quarterly.

Nine short link probes (from Genitron Instruments) are mounted in the surroundings to continuously monitor the dose rates. Additionally two mobile units are placed in OKG shelter to be used in an emergency situation. The probes use radio transmission to send encrypted data to the central unit where the data is decrypted, stored and presented using the Genitron software "DataExpert". The central unit is in its turn connected to an alarm system (517). When the alarm threshold set in DataExpert is exceeded, the central unit gives a signal to the 517 alarm surveillance computer in the CLAB control room.

To be able to warn the CLAB staff in emergency situations dose rate monitors are installed at the main entrance and the security centre (TBC) as well as in the control room. Three mobile units to be used in an emergency situation are sited at 0SKY and the reserve KC at OKG. The instruments are Automess Gamma-Alarm-Station 859.1 (GAS) with a battery backup (changed every 5 years). In case of loss of current the battery is able to keep the instrument in operation for approximately 150 hours.

The GAS has a visual and audible alarm. The active part containing the detector is a hand held dose rate instrument from Automess (6150 AD5R/H) that is calibrated annually. The function of the GAS is tested once every 12 months. Calibration and function testing is documented in the calibration software ATIVA.

5.4.4 Meteorological monitoring system

The OKG/CLAB meteorological station consists of a meteorology tower about 1 km from CLAB. There are measuring points for temperature at heights of 2, 10, 70 and 100 m. Wind speed and direction are measured at 10, 70 and 100 m. Measurement data is transferred to a database and to the SSM through the WeatherService-application. Data can be reached from computers within the plant. For the transfer of data to the Swedish Meteorological and Hydrological Institute (SMHI) two cables are used; one fibre-optic and one copper, this to give redundancy to the system.

6 AERIAL AND LIQUID DISCHARGE MONITORING AT THE CLAB FACILITY

6.1 INTRODUCTION

CLAB facility normal operation results in discharges of small amounts of gaseous and liquid radioactivity in the environment. Discharges are carried out in a controlled manner. Each year in October a calculation of discharges is presented for the following year, based on the planned activities in the facility. During the year the actual discharges are compared to the forecast on a monthly basis. Estimates cover the dose to a representative person in the critical group (children aged 7-12) from both liquid and aerial discharges. It also includes calculated discharges from specified nuclides relevant for the CLAB facility.

6.2 AERIAL DISCHARGES

The air discharge point is the main stack. The monitoring system (553) contains one stack loop and two parallel measuring loops. A gas flow meter (553KB321) is mounted in the main stack with the objective to measure the air flow and indirectly the volume that is discharged through the main stack. This parameter is needed to evaluate the activity in the discharged air. Beside the main stack flow meter all other equipment in system 553 are located in a room close to the main stack.

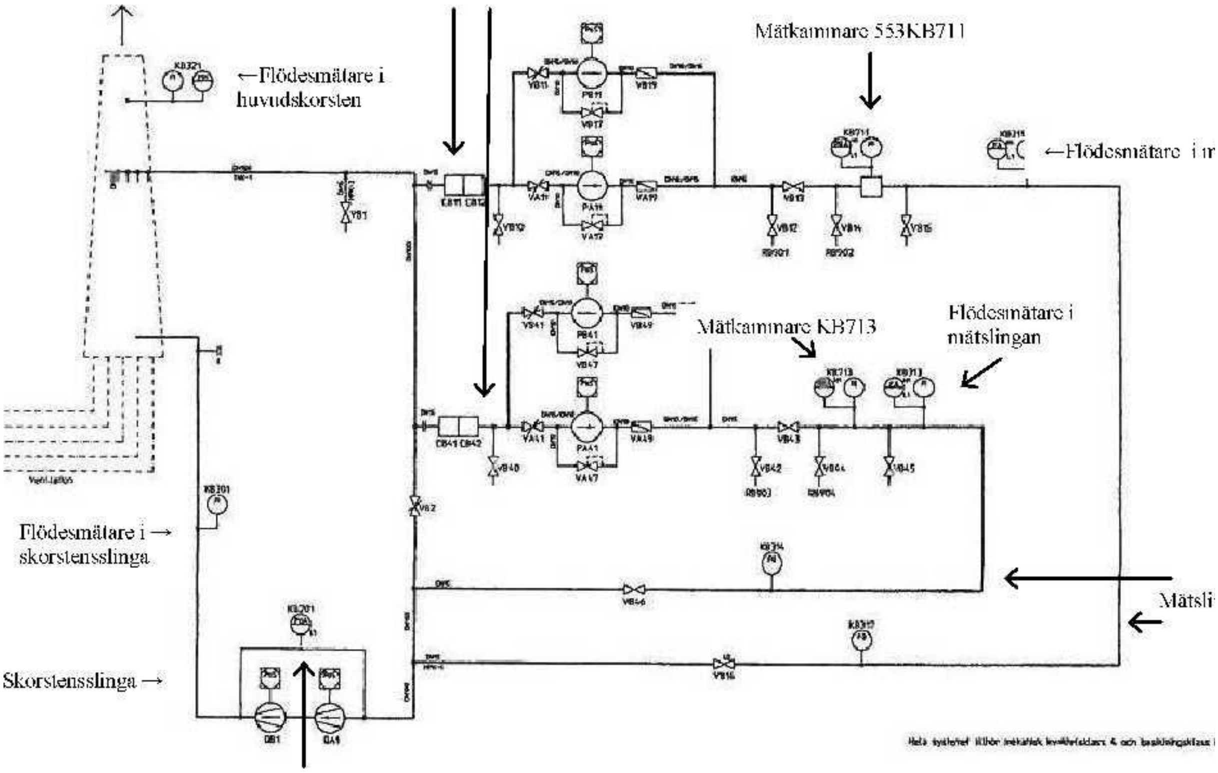

Figure 2. The main stack activity monitoring system

An isokinetic flow is taken from the main stack and the stack monitoring loop. The stack loop contains two redundant fans and a flow meter connected to two parallel measuring loops. Each measuring loop contains a filter cartridge, two air pumps, a measurement chamber, a flow meter and an integrating total air flow meter. The air pumps provide an isokinetic flow to the measuring loops. If the airflow is too low in a loop the redundant fan or air pump starts automatically.

The filter cartridge is a combination filter with a glass-fibre filter attached to a carbon filter cartridge. The aerosol filter is changed and analysed for gamma emitting nuclides and total α once a week.

The on-line measuring chambers are located after the filter cartridges. A detector is mounted in each measuring chamber. The detector 553KB711 is a beta detector with the objective to detect Kr-85, indicating fuel encapsulation damage. This nuclide is the only radioactive noble gas nuclide that is anticipated during normal operation. All other noble gas radionuclides have decayed before the spent fuel arrives to CLAB. A radiation shield protects the detector from background radiation and makes the environment as constant as possible. The electronic equipment in the detector converts the pulse frequency to concentration of Kr-85. The measurement system is from Berthold, Germany (LB 6350-1S). The signal from this detector is continuously displayed in the control room. Digital alarm signals are given to the signalling system if the pulse rates are lower than the background or higher than a pre-set limit.

In addition to continuous Kr-85 monitoring the SSM requires the installation of an emergency detector to detect activity releases in case of an emergency[3]. The objective of the detector in the measuring chamber in the second loop (553KB713) is to identify gamma emitting noble gases, which may occur during abnormal events, like criticality. The emergency detector, from Berthold, Germany (LB 6701-10) was installed in2008. It is mounted in a measuring chamber detecting gamma radiation in air passing through the main stack. The detector is located after the filter cartridge and the detector signal is continuously displayed in the control room. The function of the detector is continuously monitored using an attached control source (2.5 kBq Cs-137). The alarm system is programed to send a signal if values are higher or lower than pre-set values. Alarm limits and links to local central display systems are regularly controlled.

In each measurement loop there are valves installed to manually manage air sampling for laboratory analyses if the measuring system malfunctions. The CLAB maintenance department checks detector functioning monthly using a Cs-137 source. The source makes it possible to control detectors and electronic equipment, alarm limits and activity levels.

[3] The requirement in section 30 of SSMFS 2008:15 says "Monitors for measurements of radiation levels in the event of an emergency shall be permanently installed in the main stack and near other controlled exhaust pathways. The monitors shall be able to measure radiation levels that might occur in an emergency situation. The measurement readings shall be shown in a central location at the facility."

Figure 3. CLAB main stack and air discharge sampling and monitoring devices

Figure 4. Kr-85 monitor of the aerial discharge monitoring system

6.3 LIQUID DISCHARGES

The purpose of the water discharge system (375, Fig. 5) is to receive and store water from the purification systems and to make possible measurement of the activity level in the water. If the water is accepted for discharge it will be transferred to the recipient by CLABs cooling water system 713. If it is not accepted for discharge it will be returned to the purification systems.

Sampling equipment including a sampling tank (375TB21) is connected to the storage tanks (375TA11 and 375TB11). The sampling is proportional to the discharge flow rate. The water in the sampling tank is used for analysis of the discharged activity.

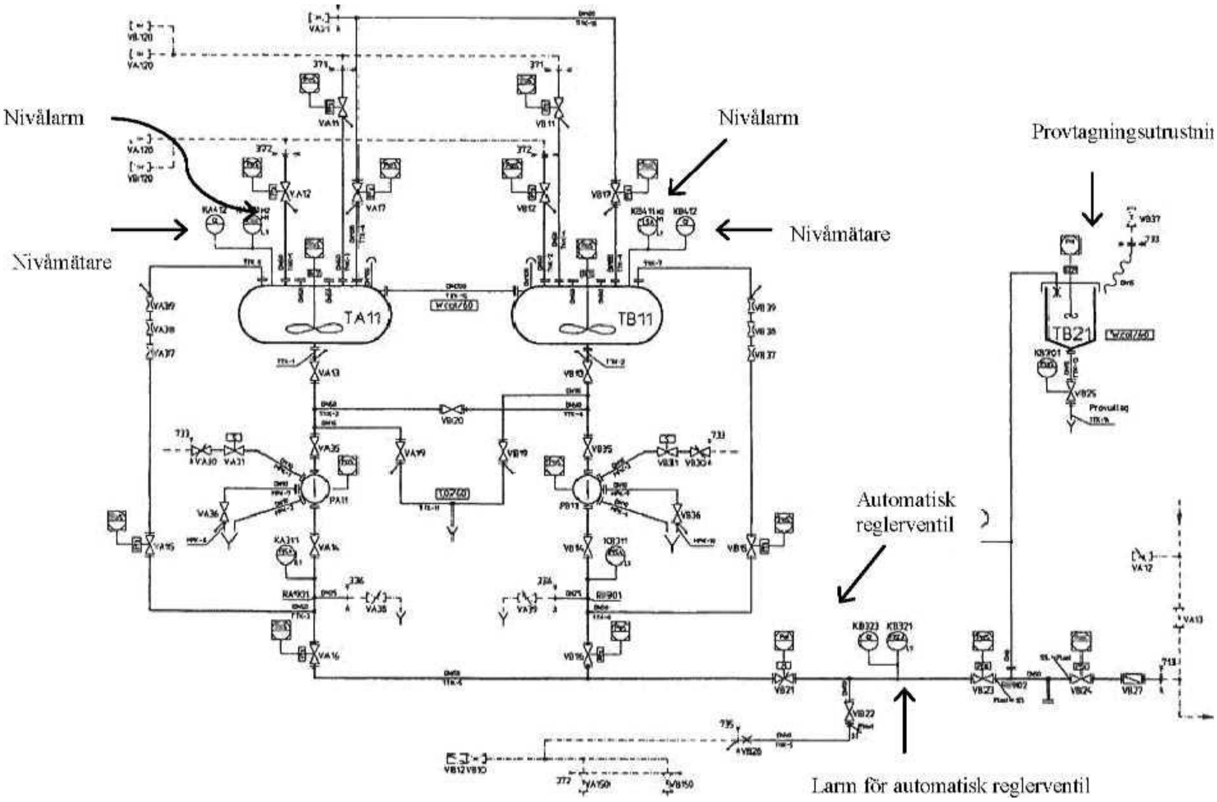

Figure 5. System for discharge of water from the controlled area

7 LABORATORIES PARTICIPATING IN THE DISCHARGE AND ENVIRONMENTAL SURVEILLANCE OF THE CLAB SITE

7.1 CLAB CHEMICAL AND RADIOCHEMICAL LABORATORY

7.1.1 Introduction

At CLAB there is a radiochemical laboratory in the controlled area. Samples from several different systems are analysed in this laboratory. The laboratory has separate rooms for chemical and radioactivity measurements. Nuclide specific gamma measurements are performed with HPGe detectors (EG&G Ortec). For evaluation Gammavision 32 software is used. The detectors have a relative efficiency of 10 %. The detector systems are controlled using a multi-nuclide calibration standard of Am-241, Cs-137 and Co-60. Background checks of the detectors are done every week. QA and background measurements are stored in the laboratory database.

To measure total alpha the laboratory has a detector with a ZnS-layer. This detector is not used for statutory monitoring.

7.1.2 Sample reception

When samples are taken to the laboratory they are registered in the laboratory logbook and also in a Excel database. The sampling point, date and time are noted. The database also contains the sampling schedule for CLAB.

7.1.3 Sample analysis - aerial discharges

Gamma

Aerosols in the exhaust air are captured on the aerosol filter mounted in the filter cartridge. The filter (glass fibre) is removed from the filter cartridge. The filter is put in a small Cerbo-dish; sample information (system number, date and time of removal from the measuring loop) is written on the lid. The filter is measured on a HPGe-detector. The measurement starts four hours after removal from the system 553. Nuclides normally identified on the aerosol filter are Co-60 and occasionally Cs-137.

Gammavision software is used to evaluate the activity. Using the value of the airflow in the main stack, the integrated flow in the measurement loop, the activity on the aerosol filter and the factor of losses in the measuring system the discharged activity is calculated. The analysis is performed according to the instruction "8-E6.000.12 CLAB- Nuklidspecifik gammamätning".

Sr-90

To determine the Sr-90 content in the exhaust air six aerosol filters are gathered each quarter. The nuclides on the filter are extracted by chemical separation of Strontium. After ingrowth of Y-90, chemical separation of Yttrium and evaporation of the Yttrium phase, measurement of Y-90 with a proportional counter follows. The measurement is repeated during the following week. The analysis is outsourced to Studsvik Nuclear according to the Studsvik instructions "IN-1146 Preparation av filter inför Sr-90-sep", "IN-0215 Analys av Sr-90", "IN-0152 Sr-90 mätrutiner" and "IN-0164 Beräkning och rapportering av resultat".

Alfa

For alpha activity measurements six aerosol filters are gathered each quarter. The filters are trace-labelled using 0.03 Bq Np-237. Before separation the filters are leached using aqua regia (HNO3+HCl). The alpha emitting nuclides are analysed by conventional electrode deposition on to a small plate in an electrolyte-cell. The plate is measured by alpha spectroscopy. The added tracer is needed for evaluation since the system calibration depends very much on the quality of the layer on the plate. Alpha spectroscopy is made on detectors from Ortec and the results are calculated with Alpha Ensemble. The analysis is performed by OKG according to the OKG instruction; "Instruktion för alfaspektrometri; Reg nr 2001-07845"

7.1.4 Sample analysis - liquid discharges

Gamma

The discharge water sample is filtered through a glass fibre filter and the filter and filtrate is analysed. The filter is placed in a petri-dish and measured on an HPGe-detector for 50 000 seconds. The analysis is performed by SKB according to the instruction "8-E6.000.12 CLAB Nuklidspecifik gammamätning".

H-3

In H-3 analysis 30 ml of a monthly sample is shaken vigorously together with ion exchange resin. 5 ml of the filtrate is mixed with 10 ml liquid scintillation fluid (Optiphase Hisafe 3). Background samples are prepared as well. The samples are analysed on a Perkin Wallac Guardian 1414 liquid scintillation counter. The analysis is performed by OKG according to the OKG instruction "Instruktion för hantering av kol-14 och tritiumprover mäts med vätskescintillation; Reg nr 2002-03039".

Sr-90

In Sr-90 analysis one litre out of a three month batch sample is used. Sr-90 is separated using specific ion exchangers for strontium. Stable strontium is used to determine yield accuracy in analysis. The analysis is performed by OKG according to the OKG instruction "Instruktion för bestämning av Sr-90; Reg nr 2004-02246".

Alpha

In Alpha analysis 50 ml of water from the monthly sample is mixed with 0.02 Bq U-233 tracers. The sample is evaporated and electro-deposited on to a small plate in an electrolyte-cell. The plate is measured in an alpha-spectrometric system. The added tracer is needed for evaluation since the system calibration depends very much on the quality of the layer on the plate. Alpha spectroscopy is carried out and the results are calculated with Alpha Ensemble software. The analysis is performed by OKG according to the OKG instruction "Instruktion för alfaspektrometri; Reg nr 2001-07845".

7.1.5 Statutory accounting and reporting

The results are stored in the laboratory database as an Excel-file. Analytical results (evaluated results and raw data) of measurements on air and water discharges are archived. There is no comprehensive policy regarding how to deal with results below detection limits.

The department of nuclear safety makes a quality check of reports sent to SSM. The reports referred to are the six-month and annual report on discharges to the environment. The reports are issued by the chemical department (TDK) and approved by the manager of CLAB. In addition to the written reports, physical samples according to SSMs annual request are sent to SSM.

7.1.6 Sample storage and archiving

Water samples are kept for 10 years. The samples, stabilized with HNO_3, are weighted annual samples of at least 5 litres. Aerosol filters are stored for at least 10 years.

7.1.7 Quality assurance and control

A QA control is done daily on the HPGe-detectors. Background checks are done every week to find background variations and contamination. If the background is significantly raised the detector is cleaned and the background checks repeated. Background checks are registered in the laboratory database.

CLAB laboratory is not accredited. It participates in an inter-calibration exercise with other Swedish nuclear power plants once a year. In these exercises comparison of the measurement of radioactive water by gamma spectroscopy is arranged.

7.2 OKG LABORATORY FOR ENVIRONMENTAL SAMPLES

7.2.1 Introduction

The laboratory for handling environmental samples is operated by OKG and located at Oskarshamn 3 outside the controlled area. It has separate rooms for sample preparation and measurements of radioactivity.

7.2.2 Sample identification and registration

Sampling is done by staff from SLU at Simpevarp. This is formalized in an agreement with SSM since it is considered important that an independent agency does the sampling.

Samples are recorded in a binder when they are delivered at the laboratory. Each sample is labelled with a serial number and a registration sheet is filled in for each sample. After measurement each sample is registered in a database.

7.2.3 Sample preparation

The samples are dried and some samples such as sediments and sludge, are ashed.

7.2.4 Sample measurements

Samples are measured for 85 000 seconds on an HPGe-detector. The nuclide library used in the gamma spectrum analysis is set by SSM according to instruction SSI 2004:15 "Omgivningskontrollprogram för de kärntekniska anläggningarna".

7.2.5 Measurement devices in the laboratory

The laboratory has two HPGe-detectors (Ortec). Calibration of the equipment is performed with commercial standards. Calculations of the results are performed with Ortec Gammavision software. Detection limits are given in the reports for 12 specified nuclides; all other detection limits are on the print-out of the measurement results.

7.2.6 Statutory accounting and reporting

Reporting to SSM is carried out in 6 monthly and annual reports with agreed parameters. The Chemistry department of OKG is responsible for producing the reports.

7.2.7 Sample storage and archiving

Measured samples are kept in interim storage for 18 months after which they are transferred to the central archive at CLAB where they are stored for at least 10 years.

Result values on paper are stored in an interim archive for approximately 18 months and then transferred to the central archive.

7.2.8 Quality assurance and control

Control of the detectors is done daily. Double samples are taken for control measurements at other laboratories. External reviews (WANO, OSART and SSM) as well as internal audits take place regularly. The laboratory is not accredited but it takes part in inter-comparison exercises.

7.3 SSM LABORATORY FOR DISCHARGE SAMPLES AND ENVIRONMENTAL SAMPLES

7.3.1 Introduction

SSM has a laboratory for alpha, beta and gamma spectrometric measurements on level 2 of the SSM office building in Solna, a suburb of Stockholm. The laboratory is an integral part of the authority, which is under the governance of and reports to the Ministry of the Environment. The laboratory area includes low and high activity preparation rooms, low background spectrometric rooms and a low background lead shielded whole body counting room.

The analyses cover nuclide-specific measurements of the concentration of gamma radioactive substances and in some cases the concentration of tritium in water samples. The samples received as part of the surveillance program of NPPs and the measurements performed are stated below:

Discharge samples

Water discharges before and after outage period	Gamma measurement with NPP library
Combined yearly water sample	Gamma measurement with NPP library, H-3
Other control samples, unplanned grab samples that vary yearly (e.g. filters, extra discharge water)	Gamma measurement with NPP library

Site-related environmental samples

Sea water	Gamma measurement with NPP library, H-3
Marine samples	Gamma measurement with NPP library

Terrestrial samples	Gamma measurement with NPP library

7.3.2 Sample reception

The samples arrive at the SSM with sample codes, location, geographic coordinates, sample type and date given according to an order placed by the environmental monitoring program at SSM. All information accompanies the samples on paper and is officially registered at the authority upon receipt of the delivery. Each sample is also labelled with its code. This sample information is recorded twice in the laboratory: electronically in the counting/analysis systems and on paper records.

7.3.3 Sample preparation

There are two sample preparation rooms with separate areas and equipment for low activity versus higher activity samples. Samples are received from the environmental monitoring program, the specific NPP discharge or site-related environmental programmes, different supervision activities or from different inter-calibration programs. In the event of an emergency, a plan for the use of the preparation rooms exists, including procedures for handling an unknown sample.

The following methodologies are used to prepare samples before measurement:

Gamma

Samples are either fresh or dried in the following geometries: 1000 ml Marinelli beaker (M1000), 200 ml cylindrical container (S200), 60 ml cylindrical container (C60) and 35 ml cylindrical container appropriate for filters (Filter).

Sr-90

This nuclide is measured from its daughter product Y-90 at equilibrium by organic extraction and scintillation counting. The sample is ashed at 610° C. The ash is dissolved in HCL at pH 1.0-1.2 and the Y-90 is extracted from the solution with 10% HDEHP. Y-90 is back extracted into HNO_3 and precipitated as hydroxide. The hydroxide precipitation is dissolved in HNO_3 plus H_2O, then transferred to a liquid scintillation vial and the Cerenkov radiation from Y-90 is counted in a LSC counter Quantulus 1220.

Tritium

15 ml of the sample is treated with a mixture of anion and cation exchange for ten minutes. The sample is then stored for 30 min and after that filtrated through an OOH filter. Between 1-8 ml of the sample is mixed with 10 ml Ultima Gold LLT cocktail. With every measurement a blank sample and a tritium standard sample are also measured in a Quantulus 1220 LSC counter.

Gross-alpha, gross-beta and Ra-226

38 ml of water is freeze dried and mixed with 20 ml Opti Phase HiSafe 3 and measured with the LSC Quantulus 1.

7.3.4 Measurement devices in the laboratory

Nuclide specific gamma spectrometry measurements are performed using four multichannel analysing systems with HPGE detectors (Tennelec, Ortec, Canberra), relative efficiencies 18, 50, 45 and 52 % respectively. Measurements electronics come from Canberra (DSA 2000). Genie software is used for both hardware control and spectral analysis evaluation. The Canberra package APEX is used as the Genie shell providing integration of the counting system with the laboratory operation, database and quality assurance services. The samples are measured for at least 24 hours to meet the required limit of detection (2 Bq/kg). The measurement uncertainties are stated as one standard deviation.

The laboratory has two low background liquid scintillation spectrometry counters (Wallac Quantulus 1220). Software WinQ and the analysis software EasyView are also from Wallac. Activity calculations are performed using formulas in Excel. H-3 and Sr-90 are measured for 6 hours. Other samples measured on the Quantulus vary in measurement time from 30 minutes up to five hours. The measurement uncertainties are stated as one standard deviation.

7.3.5 Measurement procedures

Counting and analysis procedures used during gamma spectrometry are subdivided into environmental, NPP and emergency categories. Counting and analysis sequence and libraries for the analysis differ depending on the sample type. For each of these categories a variety of geometries are implemented, each with its own calibration. All reference sources used for efficiency calibrations are traceable to primary standard references. The Genie/Apex system provides the calculation of the activity concentrations and gives reports on the detection limits, which are registered and archived at the authority. The results are stored in the Apex database and can be retrieved for re-analysis.

The concentration of gamma radioactive substances is determined by gamma-spectrometry using the NPP library. It contains, among others, the following nuclides important for reporting: Cr-51, Mn-54, Co-58, Fe-59, Co-60, Zn-65, Nb-95, Ag-110m, Sn-113, Cs-134, and Cs-137. The environmental library contains nuclides relevant for the type of sample that is measured, including both natural and manmade radionuclides. Appendix 3 shows the nuclides which shall always be reported.

7.3.6 Data handling and reporting

SSM maintains two databases for discharge and environmental data from the nuclear facilities. These are used as a base for reporting to different organisations, for evaluations and for writing reports and giving information to the public.

SSM reports monitoring results to:

- EU under Euratom Treaty Article 36
- HELCOM
- OSPAR
- Swedish National Board of Health and Welfare
- Swedish National Food Administration
- Swedish Board of Agriculture
- Swedish Dairy Association
- Swedish Water & Wastewater Association

7.3.7 Sample storage

All samples from the nuclear facilities are stored for 10 years in the laboratory area.

7.3.8 Quality assurance and control

For the gamma spectrometry measurements a QA check using known references is carried out every second day. The QA reference sources, traceable to NIST, are in filter geometry containers and consist of Am-241, Cs-137 and Co-60. The controlled parameters are peak energy, peak position in the spectrum, activities and counts per second. Warnings for "investigation" or "take action" are prompted in case of deviation from the true values over $\pm 2\sigma$ and $\pm 3\sigma$, respectively. The QA results are stored in the system database and can be retrieved for later analysis.

Background checks are done monthly with the geometries of the plastic containers (Marinelli beaker 1000 ml, Sarstedt 200 ml and Cerbo 60 ml). Warnings for "investigation" and "take action" are prompted in case of deviation from the previous background. The background history is also stored in the system database and can be retrieved for later analysis.

Quality assurance checks are also implemented for the LSC Quantulus 1220. A background sample is measured before every batch.

Database pointers (measurement parameters, calibrations, measurements performed with their results, the spectral data and the hardware electronic settings) are automatically backed up every day according to the routines in place for SSM IT systems and electronic data.

7.3.9 Laboratory accreditation

The laboratory is currently in the process of preparing for an accreditation according to ISO 17025. The planned scope of the accreditation is the determination of anthropogenic radionuclides in water samples with gamma spectroscopy, which will cover many of the analyses for the control of discharges and the environment around the nuclear facilities.

The laboratory participates in comparative testing between the Nordic radiation safety authorities, involving alpha, beta and gamma spectroscopic comparisons and whole body counting calibrations. These vary from year to year. The laboratory participates also in the proficiency tests annually carried out by the IAEA ALMERA and also in the inter-comparisons carried out by the European Commission.

7.3.10 Outsourced measurements

Some of the measurements are outsourced. This is controlled through a call for tenders that specify in detail the requirements the SSM has for the measurements, including detection limits, measurement uncertainties and reporting details. The relevant laboratories in Sweden for these measurements are the emergency preparedness laboratories contracted by SSM that are located at various universities and one private company laboratory.

8 NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

8.1 INTRODUCTION

The national environmental radioactivity monitoring programme is outlined in the following table.

National Monitoring	Nuclides	Number of Samples	Comments	Organisations involved
Particles in air	^{137}Cs, ^{7}Be	5 stations	Weekly	FOI, SSM
Surface water	^{137}Cs, total-α, total-ß, $^{234, 238}$U ^{226}Ra	2 water plants	Spring and autumn	SSM, Studsvik
Drinking water	^{137}Cs, ^{90}Sr, ^{3}H, total-α, total-ß, ^{234,238}U, ^{226}Ra	6 water plants	Spring and autumn	SSM, Studsvik
Consumption milk	^{137}Cs, ^{90}Sr	5 dairies	4 times/year	SSM
Mixed diet	^{137}Cs, ^{90}Sr	3 hospitals	Spring and autumn	SSM
Game meat (moose and dear)	^{137}Cs	2 areas	Yearly	SLU, Jaktvårdkrets, Falma, SSM
Reindeer meat	^{137}Cs	32 villages	Varying extent in different villages	SJV, SLV
Marine sediments open sea	^{137}Cs	16 stations	Every 5th year	SSM, SGU
Marine fish	^{137}Cs	8 areas	Yearly	SSM, UMF, Riksmuseet
Sea water	^{137}Cs	6 stations	Yearly	SSM
Mapping projects				
Agricultural soils and crops	^{137}Cs	1250 locations	Year 2001-2010	NV, SLU, SSM
Airborne mapping of ground contamination	^{137}Cs, K, U, Th	Surface covering	On-going	SGU, SSM

8.2 EXTERNAL GAMMA DOSE RATE

Sweden has an automatic network of 28 stationary gamma monitoring stations throughout the country. SSM operates this network for the continuous monitoring of the radiation level. This allows an instant overall picture of the radiation situation in Sweden.

The gamma monitoring stations are located at the Swedish Meteorological and Hydrological Institute's (SMHI) weather stations. Each station has three GM tubes, two large ones for low dose rate region and one small one for the high dose rate region. The overall measurement range is 10 nSv/h - 10 Sv/h. Data is sent automatically via GSM / GPRS to the SSM. The average normal background level in Sweden is 100-150 nSv/h.

There are two types of alarms; a fixed alarm at the 400 nSv/h mark and a trend alarm, which is activated whenever the integrated dose over 24 hours differs by more than 10% from the integrated dose over the previous 24-48 hours.

Figure 6. Locations of stationary gamma dose rate monitoring stations

8.3 AIR

The National Defence Research Establishment (FOI) operates a national air monitoring network of six stations to detect particulate radionuclides in the air. Filters are exchanged twice a week, but can also be exchanged more frequently on request of the SSM. In case of a large increase in radioactive particle concentration, the system is used to assess the time-integrated air concentration in order to predict inhalation doses and ground deposition. Priority is given to sensitivity rather than rapidity. Airborne particles are collected on fibreglass filters which are sent by mail to the FOI laboratory in Stockholm where they are analysed in a low-background high-resolution gamma spectrometer. The detection limit is of the order of 0.1-1 $\mu Bq/m^3$.

The coverage of fixed stations is completed by a set of mobile stations which can be transported quickly to regions where additional sampling capacity is needed. In addition, there are about 20 mobile air-filter stations of different kinds operated by the county administrations (in counties where NPPs are located), the nuclear power stations, FOI and SSM.

8.4 WATER

8.4.1 Surface water

Surface water is monitored in the sparse network, i.e. two stations representing the southern and the northern region of Sweden. Surface water from the lakes Målaren and Storsjön are sampled as incoming water to the water plants in Norsborg and Östersund respectively. Ten to twenty litres of raw water is collected from the incoming water by the water plant personnel twice a year (spring and autumn). The samples are analysed at the SSM laboratory for Cs-137, total-α, total-β, U-234, 238 and Ra-226.

8.4.2 Drinking water

Drinking water is also sampled at water plants, but in this case as outgoing water. In addition to the water plants in Norsborg and Östersund, samples are taken at water plants in Göteborg, Sandviken, Luleå and Kramfors (the dense network).

Ten to twenty litres is collected at Norsborg and Östersund twice a year (spring and autumn). The samples are analysed at SSM for Cs-137, Sr-90, H-3, total-α, total-β, U-234,238 and Ra-226.

Samples of five litres are taken in Göteborg, Sanviken, Luleå and Kramfors twice a year (spring and autumn). These samples are analysed for Cs-137, Sr-90 and H-3 at an external laboratory due to the limited capacity of the SSM laboratories.

8.4.3 Sea water

Sea surface water (10 litres at 1 m depth) is collected 1-2 times a year at six locations. The samples are specifically analysed for H-3 and Cs-137 after precipitation on prepared filters. A gamma radiation analysis using the same nuclide library as for measurements of discharge waters is performed on a one litre subsample.

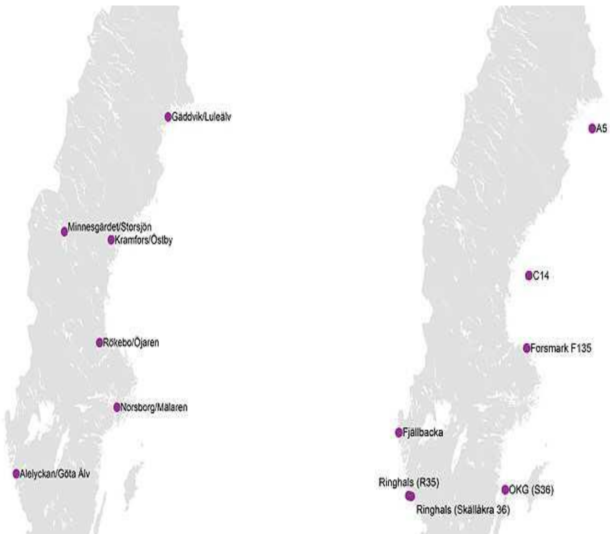

Figure 7. Sampling stations for fresh surface water and drinking water (left) and marine surface water (right)

8.5 Soil and sediments

Sea sediments are collected yearly at four locations in the Bothnian Sea as a complement to the sediment samples collected within the local recipient control around nuclear facilities. Sea sediments in open sea are collected every fifth year at 16 locations around the Swedish coast (figure 8). Sediment cores (10 cm diameter) are sampled and sliced into 1 cm thick layers on the sampling vessel. Samples are then freeze dried and analysed for Cs-137.

Cs-137 in agricultural soils has recently (2001-2010) been mapped in Sweden. Top soils (0-20 cm) have been collected at approximately 1250 locations and analysed for Cs-137. At each location, nine subsamples were taken within a six meter diameter circle and then combined to bulk samples. Crops at the same locations were also sampled (four subsamples of 0.25 m^2 are combined into a bulk sample). This mapping project was coordinated with the national program for soils and crops where samples from the same locations are analysed for humus content, soil texture, pH, plant nutrient and trace elements.

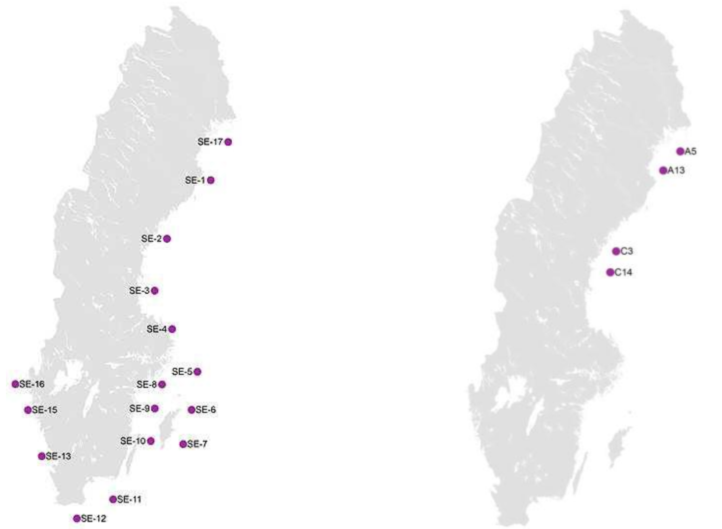

Figure 8. Sampling locations for sea sediments in the open sea (left) and complementary stations in the Bothnian sea (right)

8.6 TERRESTRIAL AND AQUATIC BIOTA

Marine fish samples are collected yearly at seven sites as well as blue mussels samples at two sites as a complement to the samples collected within the local recipient control around nuclear facilities.

Samples of elk meat from two hunting districts affected by the Chernobyl accident are analysed yearly. In the Gävle area 300-400 samples are analysed every year; the corresponding number for the Heby area is approximately 50 samples. The samples are collected by the hunters themselves and sent to the laboratory where they are analysed for Cs-137.

Figure 9. Sampling locations for marine biota (left, circles = fish samples, triangles = mussel samples) and elk meat (right)

Reindeer meat is sampled and measured at slaughter according to the decision of the National Food Agency to safeguard against meat exceeding 1 500 Bq/kg Cs-137 reaching the retail system. These data have historically been reported to SSM. There are currently some 400 000 data entries from reindeer meat monitoring measurements.

8.7 FOOD

8.7.1 Milk

The sampling program of dairy milk has been changed several times in order to fulfil the objectives in an optimal way. The latest change was done in 2005. One of the objectives was to adapt the reporting to follow Article 36 of the Euratom Treaty.

Sampling is carried out at 5 dairies. In 2006 these dairies covered 65 % of the dairy consumption milk production in Sweden and 78 % of the total intake of Cs from milk consumption. The dairies are located in Malmö, Jönköping, Kallhäll, Sundsvall and Umeå. Random quarterly sampling is carried out at the end of the dairy process where the filling of the containers intended for end consumer use is done. The sample quantity is 2 litres, of which one litre is used for the analysis.

All samples from the dairies are measured for Cs-137 and K-40. Samples from Kallhäll and Umeå are measured for Sr-90 (the reason for only measuring Sr-90 in two dairies is that the variation in the concentration of Sr-90 is not as significant as for Cs-137).

Figure 10. Milk sampling locations

8.7.2 Mixed diet

Mixed diet is collected in hospital canteens at Stockholm, Gävle and Umeå. Sampling consists of all complete meals during a 24 hour period served to a patient without any dietary restrictions. Sampling is done twice a year, in the spring and autumn. Stockholm and Umeå represent the southern and northern region in the sparse network. Cs-137, Sr-90 and K-40 are measured.

Gävle is sampled in accordance with the European Commission Recommendation 2000/473/EURATOM on the application of Article 36 of the Euratom Treaty to monitor foodstuffs which are affected by the Chernobyl fallout.

8.7.3 Foodstuffs

Sampling of various foodstuffs (including wild foodstuffs) as a mean for assessing the exposure of the population as a whole in agreement with the Article 36 of the Euratom Treaty, is currently not carried out. An exception is the elk meat sampling and the monitoring programme for reindeer meat (section 8.6).

9 LABORATORIES PARTICIPATING IN THE NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAM

9.1 INTRODUCTION

All parts of the national environmental radioactivity monitoring program (except reindeer meat), are organised by the SSM. In case there are external laboratories involved in sampling or analysis, this is done on a commercial basis and the laboratories report their results directly to SSM; their responsibilities are restricted to do what has been specified by the SSM when ordering the service.

The reindeer surveillance is carried out by the Food Safety Authority (Livsmedelsverket) and financed by the Ministry of Agriculture (Jordbruksverket).

9.2 SSM RADIOANALYTICAL LABORATORY

SSM's laboratory performs measurements on milk, drinking water, surface water, marine water and mixed diet within the national monitoring program. For description of the laboratory see section 7.3.

9.3 FOI UMEÅ

FOI in Umeå analyses sediment samples from the Bothnian Sea on behalf of SSM. Samples arrive at the laboratory from the sampling organisation Umea Marine Research Centre (Umeå marina forskningscenter) dried in cerbo-60 containers. Samples are prepared and analysed according to the description in SSI report 2004:15. The samples are measured with HPGe- detectors (50% and 80%) and the results evaluated with GammaVision 6.0. The maximum required counting time of 24 h is normally used but the requested limit of detection for Zn-65 (2 Bq/kg) in many cases is not met during this counting time. Results are corrected for different geometries between the samples. Results are reported to SSM in an Excel-file as Bq/kg dry matter. The total standard uncertainty is expressed according to EAL-R2-SV (1999) and corresponds to one standard deviation. Minimum detectable activity (MDA) is calculated according to L.A. Currie, Anal. Chem., 40, 586, 1968. MDA values are reported when no activity could be detected. FOI follows systematic quality assurance procedures and the laboratory takes part in national and international intercomparison exercises. Samples are not archived.

9.4 STUDSVIK NUCLEAR AB

Studsvik measures radionuclides in drinking water and biota samples. Drinking water is sampled by the municipality water plants and sent to Studsvik in five liter containers. Measurements are performed with methods meeting the EU reporting levels, i.e. SSM requires MDA values of 80 Bq/l (tritium), 0.09 Bq/l (Cs-137) and 0.05 Bq/l (Sr-90). Tritium is measured by liquid scintillation after distillation of a 100 ml sub-sample. Cs-137 is measured using 1 litre Marinelli containers after evaporation of the sample to 1 liter. Sr-90 is measured using a proportional counter (total beta) after separation of Sr in the sample by the use of Eichrome Sr-resin columns, followed by ingrowth of Y-90 during a week, followed by a new separation to get rid of Sr-90. Sample (Y-90) is then measured for a week, after which the decline in beta-activity due to decay of Y-90 is used for calculation of Sr-90 activity in the original sample. Biota samples are measured using HPGe detectors according to the instructions given in SSI report 2004:14. Results are reported to SSM in an Excel file together with measurement uncertainty.

Studsvik follows systematic quality assurance procedures, and the laboratory takes part in national and international intercomparison exercises. Studsvik Nuclear AB is certified under ISO 9001, ISO 14001, OHSAS 18001 and AFS 2001:1. The laboratory is partly accredited under ISO 17025 (some methods) and is aiming for the equivalent quality for all methods used. The laboratory is also certified for good manufacturing practice by the Medical Products Agency. Samples are not archived.

9.5 Swedish University of Agricultural Sciences (SLU)

SLU is a contracted emergency laboratory that could be used by the SSM in the event of an emergency. The laboratory also performs measurements of Cs-137 in elk meat. Samples are collected from the hunters together with a protocol giving information about the samples (e.g. date, coordinates, age, and weight). Samples are measured in cerbo-60 containers on HPGe detectors for up to 24h or until a measurement uncertainty of 5% is reached. Results are reported to the SSM in an excel file as Bq/kg fresh weight together with measurement uncertainty (1 standard deviation). The laboratory follows systematic quality assurance procedures and takes part in national and international intercomparison exercises. Samples are not archived.

9.6 Falma Provtagning

Falma performs measurements of Cs-137 in elk meat. Ready to measure samples (Cerbo-100 containers) are collected from the hunters together with a protocol giving information about the samples (e.g. date, coordinates, age, and weight). Samples are measured with a NaI detector (3"x3") until a measurement uncertainty of 10 % is reached. Usually a counting time of one hour is sufficient. The detector is calibrated weekly with a homogeneous Cerbo-100 geometry calibration sample from AEA Technology with a current activity concentration of about 1500 Bq/kg. Results are automatically evaluated using Genie-2000 software and sent to the SSM in an Excel file. Results are printed and stored in binders; results and gamma spectra are also stored electronically. Samples are not archived.

The laboratory is certified by the Swedish Environmental Protection Agency regarding sampling of discharge water samples and environmental samples for local monitoring program around industrial activities. Measurements of Cs-137 are not certified. Intercomparison exercises involving other laboratories are performed yearly.

9.7 Totalförsvarets Forskningsinstitut (FOI)

FOI manages the sampling and measurements of radionuclides on airborne particulates, as described in section 8.3.

9.8 Geological Survey of Sweden (SGU)

SGU performs the sediment sampling within the national program for metals and organic pollutants in sediments in open sea on behalf of the Swedish Environmental Protection Agency. An extra sediment core is taken for the SSM in order to measure Cs-137. The sampling follows the QA procedures of the national monitoring program. Sampling is done by means of a double gravity corer (GEMINI corer). The samples are sliced into 1 cm thin slices on board the ship and freeze dried before being sent to the laboratory for measurement of radionuclides.

9.9 Umeå Marina Forskningscentrum (UMF)

UMF performs sampling of sediments, fish and surface water in the Bothnian Sea. Samples are sent to other laboratories for measurement of radionuclides (sediments to FOI Umeå, fish to Studsvik and surface water to SSM). UMF is accredited by the Swedish Board for Accreditation and Conformity Assessment (SWEDAC) for sampling methods used at sea.

9.10 NATURHISTORISKA RIKSMUSEET (NRM)

NRM performs sampling of fish and mussels within the national monitoring program for metals and organic pollutants in marine biota run by the Swedish Environmental Protection Agency. NRM takes extra samples for SSM within this program at certain locations. Sampling thus follows the QA procedures of the national monitoring program and the guidelines given by HELCOM and OSPAR where appropriate. The samples are sent to Studsvik for analysis of radionuclides.

10 MOBILE MEASUREMENT SYSTEMS

The Swedish resources for mobile measurements consist of the following platform/detector systems:

- A fixed wing airplane with one 16 litre NaI and one 100% HPGe detector. The system is placed in Gävle.
- Three Chevrolet pick-up trucks with two 4 litre NaI and one 100% HPGe detector, different types of handheld spectrometric and gross counting detectors and equipment for soil sampling. The trucks are placed in Umeå, Stockholm and Lund.
- Three containers with one 4 litre NaI and one 100% HPGe detector are placed in Umeå, Stockholm and Gothenburg. They have also a lead shield for sample measurements, different types of handheld spectrometric and gross counting detectors and equipment for soil sampling.
- Helicopters (a total of seven is available) from the Swedish Police force with one 4 litre NaI and one 100% HPGe detector (exchangeable with the carriers).
- Three backpack systems with a 3"x3" NaI detector. These systems are placed together with the trucks.

The systems have computer based data collection and analysis software, with focus on online visualisation of the data. The main tasks are mapping of radioactive fallout and search for orphan sources.

The systems are owned by the SSM but operated under contract with different specialist organisations such as the Swedish Defence Research Laboratory, radiological laboratories from the Universities and Swedish Geological Survey.

11 VERIFICATIONS

11.1 SSM LABORATORY FOR DISCHARGE AND ENVIRONMENTAL SAMPLES

The verification team examined the arrangements for sample handling, measurement, analysis and storage at the SSM laboratory, which is described in section 7.3.

It was noted that sample registration was done on paper; there is no common electronic sample database in the laboratory. This works as long as the number of samples stays low, but in the event of a large increase in the number of samples (emergency situation) an electronic sample management system would be needed. The laboratory is already in the process of acquiring a new sample database.

The verification team was informed that the laboratory is in process of accreditation of water sample measurements.

It was observed that there were no access restrictions to the sample storage room, where the samples are archived for 10 years.

The verification does not give rise to recommendations. The verification team suggests keeping the sample storage in a locked room.

The verification team supports the on-going work towards laboratory accreditation and the project for a new sample database.

11.2 CLAB CONTROL ROOM

The verification team checked the arrangements for aerial discharge monitoring at the CLAB control room, from where the plant operators can monitor the main stack aerial discharges on a continuous basis. The monitoring system provides an alarm if a pre-set value is exceeded.

The verification team noted that the displayed value for continuous aerial discharge (KB711A2) was about 645 kBq/s. Obviously the facility is not really discharging these levels of activity. The team was informed that this represents the zero-discharge value; the displayed activity comes from internal detector background. This value is not used for discharge reporting.

The verification team finds the aerial activity discharge value displayed at the control room confusing, since it gives the impression that the facility is continuously releasing activity into the environment. The team recommends rearrangement of the system display in order to remove background effects from the displayed value.

11.3 LIQUID DISCHARGE MONITORING AT CLAB

The verification team reviewed the arrangements for monitoring liquid discharges at the CLAB facility. Waste water is collected in two 50 m^3 tanks. Before discharging a tank a pre-sample is taken and analysed in the plant laboratory.

During discharge 1/1000th of the discharge volume is collected to a sampling tank equipped with a rinsing line and a mixer to guarantee uniform tank content in order to collect the official sample. The sample collection line is equipped with a flow monitor, which terminates the discharge if no sample is collected. Typically a total of eight litres is collected from the tank; four litres for the laboratory and four litres for the sample storage.

The sample storage room is located close to the sampling site. All official samples since 1997 are kept in this locked room.

The verification team noted that the sampling tank rinsing line valve is not locked. This could lead to accidental sample dilution should somebody open the valve when the sample is in the tank.

Verification does not give rise to recommendations. The verification team suggests locking the rinsing line valve.

11.4 AERIAL DISCHARGE MONITORING AT CLAB

The verification team examined the arrangements and operational status of the system for continuous monitoring of aerial discharges at the CLAB facility. The only air discharge point from the facility is the main stack. The monitoring system contains one stack loop and two parallel measuring loops. A gas flow meter (553KB321) is mounted in the main stack to measure the air flow and indirectly the volume that is discharged through the main stack. This parameter is needed to evaluate the total activity in the discharged air. Beside the main stack flow meter all other equipment in system 553 are located in a room close to the main stack.

The verification team was informed that the system detector is tested monthly using a Cs-137 control source.

Verification does not give rise to specific remarks.

11.5 CLAB CHEMICAL AND RADIOCHEMICAL LABORATORY

The verification team verified the arrangements in the CLAB radiochemical laboratory. The small laboratory is in the controlled area with limited possibilities for analysis. SKB orders some of the analysis from other companies with radiochemical laboratories, such as OKG and Studsvik Nuclear.

The laboratory carries out measurements of liquid samples and air filters. Samples are collected by the laboratory staff.

It was noted that there was no filter colour (grey scale) identification system, which would be helpful in making sure there has actually been a continuous flow through the filter during the sampling period. (This type of system was developed at the Forsmark NPP laboratory and verified during Article 35 verification in 2009. At that time the team was informed that this type of system would be made available in all Swedish nuclear facilities.)

The laboratory has two electrically cooled HPGe detectors for measuring the samples. It was noted that the gamma spectroscopy analysis is carried out using a very extensive nuclide library containing also short-lived nuclides and nuclides not present in a nuclear facility. This is not a good practice, since the analysis becomes unnecessarily complicated and difficult to control visually. In addition the spectroscopy report becomes very long and difficult to read - generally speaking gamma spectroscopy becomes much easier when the library contains only those nuclides which can be found in the facility.

It was observed also that the HPGe detector regular control programme does not include control of detector resolution by checking the width (FWHM) of the Co-60 peak at 1332 keV. This would be a good practice in order to have an early indication of possible degradation of detector resolution.

The verification team recommends SSM and SKB to work together in order to develop a practical and well-defined nuclide library for the analysis of discharge samples and to consider implementing the grey-scale control system developed at the Forsmark NPP for air filters in all Swedish nuclear facilities.

In addition the verification team recommends including control of detector resolution (FWHM) in the laboratory's regular QA procedures.

11.6 OKG LABORATORY FOR ENVIRONMENTAL SAMPLES

The verification team verified the arrangements within the OKG laboratory for handling environmental samples. It is operated by the OKG and located at Oskarhamn 3, outside the controlled area. Currently there is only one full time employee in the laboratory. A backup person can be called upon in the case of absence.

The laboratory analyses samples collected by SLU, the Swedish University of Agricultural Sciences. Samples are mainly water sediments and fish. The verification team was able to follow a demonstration of fish sampling (catching pike using a gill net) and the gamma analysis. Fish are caught in the fjord into which the NPPs discharge water. The fjord measures about 1 km in length and there is a dam controlling the inflow of fresh water. Fish are weighed and the length noted before being filleted in exactly the same way as they would be prepared for human consumption, including de-boning and removal of the skin. In order to maximise the representativeness of a sample, sections are taken from up to 10 different individuals.

It was noted that the cod sample for 2012 had not yet been collected at the time of the verification. Instructions for sample collection and preparation are clearly defined.

Samples received in the laboratory are noted in a register with the following details recorded:

- sample reference (YY nnn)
- location of sample taking
- sample type
- date of sample (1st date in case of composite/multiple samples)
- net weight

Biota samples are freeze dried and kept in a desiccator for a few days for final drying before being roughly chopped in a food processor. The geometry used varies in function of the weight/volume of the sample with separate trays in place for unanalysed and analysed samples. The sample number is noted on the cover of the container.

Two HPGe detectors are available for analysis (Intertechnique and a GEM 20180), their relative efficiencies are rather similar (26.3% and 28%). Each detector has a card attached on which is noted the geometries for which it has been calibrated. The last calibration for each has been performed in June 2008, using a Co-60/Cs-137/Am-241 source. The calibration sources are kept in a locked safe in the laboratory.

Before any analysis is initiated an energy check (500 seconds) is run. The interior of the gamma detector chamber is protected using a plastic bag. GammaVision is the analysis and reporting software.

The laboratory is not accredited for any methods. All analyses are site specific, including sludge and rain water samples. The total number of samples analysed is around 140 annually, including 90-100 site related samples, 20 sludge and 12 rain water samples. The laboratory regularly participates in intercomparison exercises with other Swedish laboratories.

No uninterruptable power supply is available in the laboratory. Considering the number of analyses this is unlikely to pose a problem.

In addition to recording each sample in a paper ledger full details are also entered into a computer. Results are archived both in paper form and on a computer. Regular backups are made to a server.

Besides the visit to the laboratory and sampling stations around the site the verification team noted that TLDs placed around the CLAB/Oskarshamm site were well protected inside sealed electrical junction boxes which were securely fixed to buildings, or in the case of trees allowance was made for future growth. In addition the verification team were shown a 1 m^2 polyurethane plate placed close to the Oskarshamm 3 NPP outlet channel which serves to collect algae. This is changed monthly and it was pointed out that winter growth is half that observed in summer.

Verification does not give rise to specific remarks.

11.7 National environmental radioactivity monitoring programme

The verification team chose to visit the automatic gamma measuring station at Stavsnäs. In 2009 this gamma measurement station had been installed on the roof of the SSM building but has recently been moved to the village of Stavsnäs, some 40 km east of the city. It is situated on a rocky headland by the sea on the same site as the SMHI meteorological station and with which it shares it's power supply. The instruments which are sited at a height of 2m above the ground, in accordance with the manufacturer's instructions, are securely filed to steel bars anchored in the rock. Whilst there are a number of pine trees in the vicinity their growth is very stunted due to the lack of soil and exposure to the prevailing winds, thus their presence is unlikely to affect the measurements in the foreseeable future. The area is not fenced; however the location is somewhat remote, there are some holiday homes in the vicinity but little else.

Owing to the limited time at the disposal of the verification team it was not possible to visit other stations. Nevertheless the verification team were shown photos of the 2 stations on the island of Öland which lies a short distance to the south east of Simpevarp where the CLAB store and the Oskarshamm NPPs are situated. These appeared well situated, in areas devoid of obstructions (trees, buildings etc.).

Verification does not give rise to specific remarks.

12 CONCLUSIONS

All verification activities that had been planned 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 activities, was useful.

The information provided and the verification findings led to the following observations:

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of radioactive discharges at the CLAB site are adequate. The Commission could verify the operation and efficacy of these facilities.

(2) 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 Oskarshamn nuclear site are adequate. The Commission could verify the operation and efficiency of the facilities visited.

(3) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of environmental radioactivity in Sweden are generally adequate. The Commission could verify the operation and efficiency of the facilities visited.

(4) However, in some areas the verification activities revealed room for improvement. These recommendations do not discredit the fact that the radiological surveillance of the Oskarshamn site and the CLAB storage facility is, in general, in conformity with the provisions laid down under Article 35 of the Euratom Treaty. The recommendations are detailed in the 'Main Findings' document that is addressed to the Swedish competent authority through the Swedish Permanent Representative to the European Union.

The Commission services ask the Swedish competent authority to inform of any achievements with regard to the situation at the time of the verification.

Finally, the verification team acknowledges the excellent co-operation it received from all persons involved in the activities it performed.

APPENDIX 1

REFERENCES & DOCUMENTATION

[1] SSMFS: 2008:23, The Swedish Radiation Safety Authority's regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities, ISSN: 2000-0987.

[2] SSMFS: 2008:15, The Swedish Radiation Safety Authority's Regulation concerning Emergency Preparedness at Certain Nuclear Facilities, ISSN: 2000-0987.

[3] SDDC-206 CLAB – Kontroll av gasformiga utsläpp, Företagsintern Instruktion, SKB, 2008.

[4] SDDC-205 CLAB – Kontroll av vätskeformiga utsläpp, Företagsintern Instruktion, SKB, 2006.

APPENDIX 2

VERIFICATION PROGRAMME

SWEDEN – CLAB facility and parts of the national monitoring programme

Date	Time	Activity
Monday 12 November		EC team travels to Stockholm.
Tuesday 13 November	9.00 – 12.30 13.00 – 15.00	Opening meeting at SSM offices Visit to labs at SSM and monitoring station at Stavsnäs
Wednesday 14 November	9.00 – 17.00	Team 1 – verification of discharges monitoring at the CLAB facility Team 2 – verification of on-site and off-site environmental monitoring and stations of national monitoring programme in the vicinity
Thursday 15 November	9.00 – 12.30 14.00	Team 1 - Visit to laboratories dealing with analysis of discharge samples Team 2 - Visit to laboratories dealing with analysis of environmental samples Closing meeting
Friday 16 November	9.30 – 10.30	Closing meeting/debriefing at SSM EC team returns to Luxembourg.

APPENDIX 3

NUCLIDE LIBRARY FOR ENVIRONMENTAL SAMPLES

Nuclide	Half life	Limits of detection shall always be reported	Notes
Be-7	53.4 d		Natural occurrence
Na-22	2.6 y		
K-40	1.28E9 y		Natural occurrence
Cr-51	27.7 d	Yes	
Mn-54	312.7 d	Yes	
Fe-59	44.6 d	Yes	
Co-57	270.9 d		
Co-58	70.8 d	Yes	
Co-60	5.3 y	Yes	Limit of detection <2Bq/kg
Zn-65	244.4 d	Yes	Limit of detection <2Bq/kg
As-76	26.3 h		Uncertain analysis due to short half life
Zr -95	64.0 d		
Nb-95	35.1 d	Yes	
Nb-95m	86.6 h		
Mo-99	66.0 h		
Ru-103	39.3 d		
Ru-106	368.2 d		Via Rh-106
Ag-108m	127.1 y		
Ag-110m	249.9 d	Yes	
Sn-113	115.1 d	Yes	
Sn-117m	13.6 d		
Sb-122	2.7 d		
Sb-124	60.2 d		
Sb-125	2.8 y		
Te-129m	33.6 d		
Te-132	78.2 h		
I-131	8.0 d	Yes	For milk only
Cs-134	2.1 y	Yes	
Cs-136	13.2 d		
Cs-137	30.2 y	Yes	Limit of detection <2Bq/kg
Ba-140	12.8 d		
La-140	40.27 h		
Ce-141	32.5 d		
Ce-144	284.3 d		
Eu-152	13.3 y		
Eu-154	8.59 h		
Eu-155	4.96 y		
Gd-153	242 d		
Hf-181	42.4 d		