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Forsmarks kärnkraftverk och Nationell radiologisk omgivningskontroll

Europeiska Kommissionens kontroll i Sverige enligt artikel 35

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Författare: Ann-Christin Hägg
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Abstrakt

En kontrollgrupp från Europeiska kommissionen besökte den 9–12 februari 2009 Strålsäkerhetsmyndigheten, SSM, Försvarets forskningsinstitut, FOI och Forsmarks kärnkraftverk, för att utföra en granskning enligt artikel 35 i Euratomfördraget.

Den här rapporten är en sammanställning av det underlag som Sverige lämnat till Europeiska kommissionen inför kontrollbesöket, den officiella slutrapporten från kommissionen inklusive deras sammanställning av de viktigaste slutsatserna från kontrollbesöket. Inför kontrollbesöket sammanställde SSM med bidrag från Forsmarks kraftgrupp, FKA en underlagsrapport, se bilaga 3.

Kontrollbesöket genomfördes av fyra inspektörer från Europeiska kommissionen mellan den 9–12 februari 2009. Under besöket kontrollerades bland annat SSM:s laboratorium och FOI:s system för luftfilterstationer, systemet för mätning av strålnivåer i omgivningen (gammastationerna) samt utsläppssystemen vid och omgivningskontrollen runt Forsmarks kärnkraftverk. Inspektörer från Strålsäkerhetsmyndigheten deltog som observatörer under hela besöket.

Europeiska kommissionens slutrapport från kontrollbesöket återfinns som bilaga 2 och en sammanställning av deras viktigaste slutsatser och rekommendationer finns som bilaga 1.

Bakgrund

Enligt artikel 35 i Euratom fördraget ska varje medlemsstat inrätta de anläggningar som behövs för fortlöpande kontroll av radioaktivitet i luft, vatten och jord samt för kontroll av att de grundläggande normerna följs. Enligt samma artikel ska den Europeiska kommissionen ha tillträde till dessa anläggningar för att kunna kontrollera deras funktion och effektivitet. Europeiska kommissionen kontrollerar och ger en oberoende bedömning av:

- luft- och vattenburna utsläpp av radioaktiva ämnen från en anläggning inklusive kontrollsystem.
- Halter av radioaktiva ämnen runt anläggningen och i omgivande havs-, land- och vattenmiljö, för alla relevanta exponeringsvägar.
- Halter av radioaktiva ämnen på medlemsstatens territorium.

Europeiska kommissionen meddelade år 2008 att de hade för avsikt att genomföra en sådan kontroll vid Forsmarks kärnkraftverk och vid de institutioner och laboratorier som ingår i eller har ansvar för den nationella radiologiska omgivningskontrollen i Sverige.

Syfte

Att kontrollera att Sverige efterlever artikel 35 i Euratom fördraget, med inriktning på Forsmarks kärnkraftverk

Slutsatser

Kontrollbesöket har genomförts i enlighet med Europeiska kommissionens önskemål och kommissionens bedömer att det svenska nationella övervakningssystemet är förenligt med bestämmelserna i artikel 35 i Euratom fördraget. Några få rekommendationer och förslag har formulerats som främst berör ackreditering av laboratorier och allmän kvalitetssäkring. Dessa finns sammanfattade i bilaga 1.

SSM anser att Europeiska kommissionen genomfört kontrollbesöket på ett mycket bra sätt och med hög integritet och kompetens. Strålsäkerhetsmyndigheten instämmer i de iakttagelser och rekommendationer som framkommit i samband med kontrollbesöket.

SSM avser att under 2010 genom bland annat inspektioner och föreskriftsarbete följa upp de rekommendationer och förslag som den Europeiska kommissionen har lämnat.

Strålsäkerhetsmyndigheten vill avslutningsvis tacka den Europeiska kommissionen för ett väl genomfört kontrollbesök.

Innehåll

EUROPEISKA KOMMISSIONEN
GENERALDIREKTORATET FÖR ENERGI OCH TRANSPORT

Direktorat H – Kärnenergi
Strålskydd

Huvudresultat från kommissionens kontroll i Sverige enligt artikel 35

Forsmarks kärnkraftverk

Nationell radiologisk omgivningskontroll

Datum:	9–12 februari 2009
Kontrollgrupp:	Vesa Tanner (gruppledare)
	Jean-Loup Frichet
	Alan Ryan
	Cécile Hanot
Referens till rapport:	SE-09/02

INLEDNING

Enligt artikel 35 i Euratomfördraget ska varje medlemsstat inrätta de anläggningar som behövs för fortlöpande kontroll av radioaktivitet i luft, vatten och jord samt för kontroll av att de grundläggande normerna följs.

Enligt artikel 35 ska kommissionen ha tillträde till dessa anläggningar för att kunna kontrollera deras funktion och effektivitet.

Det viktigaste syftet med kommissionens kontroller enligt artikel 35 i Euratomfördraget är att ge en oberoende bedömning av kontrollanläggningarnas lämplighet för följande:

- Luft- och vattenburna utsläpp av radioaktiva ämnen från en anläggning till omgivningen (och kontroll av utsläppen).

- Halter av radioaktiva ämnen runt anläggningen och i omgivande havs-, land- och vattenmiljö, för alla relevanta exponeringsvägar.

- Halter av radioaktiva ämnen på medlemsstatens territorium.

En kontrollgrupp från Europeiska kommissionen besökte den 9–12 februari 2009 Forsmarks kärnkraftverk på svenska ostkusten, ca 4 km norr om Forsmarks bruk i Östhammars kommun i Uppsala län, för att göra en sådan granskning. Syftet var att kontrollera funktion och effektivitet vid anläggningen och vid de analyslaboratorier som ansvarar för fortlöpande övervakning av radioaktivitet i luft, vatten och jord i kärnkraftverkets omgivningar och på Sveriges territorium. Kontrollen omfattade också anläggningens utrustning för övervakning av luft- och vattenburna utsläpp av radioaktiva ämnen till omgivningen. Med hänsyn till kontrollbesökets omfattning och den relativt korta tiden för att genomföra programmet lades tyngdpunkten på följande:

1. Utsläppsövervakningen vid Forsmarks kärnkraftverk.

2. Det nationella övervaknings- och provtagningsprogrammets uppläggning.

3. Analyslaboratorierna vid Forsmarks kärnkraftverk och vid Strålsäkerhetsmyndigheten.

4. Automatiska övervakningssystem och miljöprovtagningsarrangemang vid utvalda stationer.

Gruppen kontrollerade övervakningssystem och provtagningsarrangemang vid flera stationer inom Forsmarks kärnkraftverk och dess omgivningar. Kontrollerna omfattade både online- och offline-övervakning av radioaktivitet i miljö och livsmedel.

Denna rapport ger en översikt över kontrollgruppens viktigaste resultat och de rekommendationer dessa föranleder.

Rekommendationerna riktas till den svenska behöriga myndigheten, Strålsäkerhetsmyndigheten (SSM).

HUVUDRESULTAT

Det föreslagna kontrollprogrammet kunde slutföras inom planerad tid. Kontrollgruppen uppskattar den förhandsinformation som lämnades och den kompletterande dokumentation som erhölls under och efter besöket.

1. Huvudresultat med avseende på utsläppsövervakningen vid Forsmarks kärnkraftverk

De kontroller som gjordes vid Forsmarks kärnkraftverk

1.1 bekräftade att det finns ett fungerande program för övervakning och provtagning av utsläpp, i enlighet med de skyldigheter som anges i lagstiftningen,

1.2 visade att kvalitetssäkring och kvalitetskontroll utförs genom en kombination av skriftliga förfaranden och arbetsinstruktioner.

Dock

1.3 noterade kontrollgruppen, i fråga om punkt 1.2, att det inte fanns någon provtagningsinstruktion vid stationen för provtagning före utsläpp från tanken för utsläppsvatten.

Kontrollgruppen rekommenderar att man ser till att det finns en skriftlig provtagningsinstruktion vid varje provtagningsstation.

2. Huvudresultat med avseende på det nationella övervaknings- och provtagningsprogrammets uppläggning

De kontroller som gjordes vid Strålsäkerhetsmyndigheten (SSM) och Totalförsvarets forskningsinstitut (FOI)

2.1 bekräftade att det finns ett fungerande nationellt program för miljöövervakning och provtagning som omfattar hela Sveriges territorium i enlighet med de skyldigheter som anges i lagstiftningen,

2.2 visade att kvalitetssäkring och kvalitetskontroll utförs genom en kombination av skriftliga förfaranden och arbetsinstruktioner.

Kontrollen föranleder inga rekommendationer.

3. Huvudresultat med avseende på analyslaboratorier vid Forsmarks kärnkraftverk och vid Strålsäkerhetsmyndigheten

De kontroller som gjordes vid analyslaboratorierna vid Forsmarks kärnkraftverk och vid Strålsäkerhetsmyndigheten

3.1 visade att laboratorierna är väl utrustade och har personal med lämplig utbildning, 3.2 visade att kvalitetssäkring och kvalitetskontroll utförs genom en kombination av skriftliga förfaranden och arbetsinstruktioner.

Dock

3.3 noterade kontrollgruppen, i fråga om punkt 3.2, att inget av dessa laboratorier är formellt ackrediterat för radioaktivitetsmätningar.

Kontrollgruppen föreslår att laboratorierna går vidare mot en formell ackreditering.

3.4 I fråga om punkt 3.2 noterade kontrollgruppen att det inte tycks finnas någon formell policy för rapportering av värden under minsta detekterbara aktivitet (MDA) i Sverige och att det har inte utfärdats några riktlinjer om vilken känslighet instrumenten ska ha. I Forsmark är policyn att rapportera noll om det uppmätta värdet ligger under systemets MDA.

Kontrollgruppen rekommenderar att SSM överväger fördelarna med att revidera sina föreskrifter om ersättningsvärden för analysresultat under MDA genom att se till att kraven ligger i linje med kommissionens rekommendation 2004/2/Euratom och ISO-standard 11929-7:2005.

3.5 I fråga om punkt 3.2 noterade kontrollgruppen att ett av stabilitetstesten för effektivitet vid laboratoriet i Forsmark F3 visade på ovanligt stora variationer i HPGe-detektorers effektivitet.

Kontrollgruppen rekommenderar att man ser till att F3-laboratoriet har ett tillfredsställande förfarande för stabilitetstest av HPGe-detektorers effektivitet och att varje detektors stabilitet kontrolleras noggrant.

3.6 I fråga om punkt 3.2 noterade kontrollgruppen att vissa av mätinstruktionerna vid SSM-laboratoriet var handskrivna och att det inte tycktes finnas någon systematisk dokumentation av mätförfarandena.

Kontrollgruppen rekommenderar att analyslaboratoriet vid SSM inrättar ett formaliserat system för mät- och kalibreringsinstruktioner som en del av ett övergripande kvalitetssystem och därefter går vidare mot en formell kvalitetsackreditering.

Kontrollgruppen föreslår att SSM överväger att inrätta en databas för hantering av prover på laboratoriet. Detta är särskilt viktigt om antalet inkommande prover av någon anledning skulle öka.

4. Huvudresultat med avseende på de automatiska övervakningssystemen och miljöprovtagningsarrangemang

De kontroller som gjordes i Stockholm, Gävle och Alunda

4.1 bekräftade förekomsten av ett nationellt system för online- och offline-övervakning och provtagning,

4.2 visade att övervakningssystemet har tillfredsställande utrustning och underhåll, 4.3 visade att kvalitetssäkring och kvalitetskontroll utförs genom en kombination av skriftliga förfaranden och arbetsinstruktioner.

Dock

4.4 noterade kontrollgruppen, i fråga om punkt 4.2, att det nuvarande systemet är gammalt och att ett moderniseringsprojekt håller på att genomföras.

Kontrollen föranleder inga rekommendationer. Kontrollgruppen stöder moderniseringen av det automatiska systemet för övervakning av dosrater.

SLUTSATSER

Kontrollbesöket var framgångsrikt och granskningens syften uppnåddes. Inom kontrollverksamhetens befogenheter enligt artikel 35 i Euratomfördraget har det visats att de anläggningar som behövs för fortlöpande kontroll av radioaktivitetsnivån i luft, vatten och jord samt för övervakning av radioaktiva utsläpp från Forsmarks kärnkraftverk är tillfredsställande. Kommissionen kunde kontrollera anläggningarnas funktion och effektivitet.

Några få rekommendationer och förslag har formulerats, främst i fråga om laboratoriemetoder och allmän kvalitetssäkring. Dessa rekommendationer minskar inte giltigheten i den allmänna slutsatsen att det svenska nationella övervakningssystemet är förenligt med bestämmelserna i artikel 35 i Euratomfördraget.

Slutligen vill kontrollgruppen tacka för det goda samarbetet från alla berörda personer.

Vesa Tanner

Gruppledare

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY AND TRANSPORT

DIRECTORATE H - Nuclear Energy
Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

FORSMARK Nuclear Power Station

National Environmental Radioactivity Monitoring

SWEDEN

9 to 12 February 2009

Reference: SE-09/02

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:

- Provisions for monitoring and controlling radioactive discharges and for surveillance of the environment during normal operations of the Forsmark NPP
- Provisions for monitoring and controlling levels of radioactivity on the national territory
- The national radiological early warning network

DATE: 9 to 12 February 2009

REFERENCE: SE-09/02

VERIFICATION TEAM:
Mr V. TANNER (Head of team)
Mr J.L. FRICHET
Mr A. RYAN
Ms C. HANOT

DATE OF REPORT: 30 October 2009

SIGNATURES:

V. TANNER

J.L. FRICHET

A. RYAN

C. HANOT

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1 ABBREVIATIONS

24/7	24 hours, 7 days per week
BEGe Detector	Broad Energy Germanium Detector
BSS	Basic Safety Standards
DG TREN	Directorate-General for Energy and Transport
EC	European Commission
EURDEP	EUropean Radiological Data Exchange Platform
FKA	Forsmark Kraftgrupp AB (Forsmark NPP operator)
FWHM	Full Width at Half Maximum
GM	Geiger-Müller (radiation detector)
GPS	Global Positioning System
HELCOM MORS	Helsinki Commission – Monitoring Of Radioactive Substances
HEPA	High Efficiency Particulate
HPGe	High Purity Germanium (gamma radiation detector)
IAEA	International Atomic Energy Agency
ISO	International Standardization Organization
MCA	Multichannel Analyser
MDA	Minimum Detectable Activity
NaI	Sodium Iodine (gamma radiation detector)
NaI(Tl)	Sodium iodide crystals doped with thallium
OSART	Operational Safety Review Team
NFA	National Food Administration
SGU	Swedish Geological Survey
FOI	National Defence Research Agency
UTC	Universal Time Coordinated
QA	Quality Assurance
SKB	Svensk Kärnbränslehantering AB (Swedish nuclear waste management organisation)
SKI	Swedish Nuclear Power Inspectorate
SMHI	Swedish Meteorological and Hydrological Institute
SSI	Swedish Radiation Protection Authority
SSM	Swedish Radiation Safety Authority
UPS	Uninterruptible Power Supply

2 INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State 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.

For the EC, the Directorate-General for Energy and Transport (DG TREN), and in particular its Radiation Protection Unit (TREN H4), is responsible for undertaking these verifications.

The main purpose of verifications performed under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of monitoring facilities for:

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

From 9 to 12 February 2009, a verification team from DG TREN visited the site of the Forsmark Nuclear Power Station located on the Swedish east coast about 4 km north of Forsmarks Bruk in Östhammar Municipality in Uppsala County. The aim of the verification was to check the operation and efficiency of the facilities and associated analytical laboratories for continuous monitoring of the level of radioactivity in air, water and soil in the vicinity of the Forsmark site and on the territory of Sweden. The verification scope also covered the on-site facilities monitoring liquid and aerial discharges of radioactivity into the environment.

During the verification activities addressing the monitoring of radioactive discharges from the Forsmark NPP, the EC team was accompanied by representatives of the Swedish Radiation Safety Authority (SSM) and Forsmark NPP. During the verification activities relating to monitoring of the environment in the vicinity of Forsmark, the EC team was accompanied by representatives of Forsmark NPP.

The present report contains the results of the verification team's review of relevant aspects of discharge control and radiological environmental surveillance on and around the Forsmark site, as well as elements of the national radiological surveillance put in place by the competent Swedish authorities.

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

3 PREPARATION AND EXECUTION OF THE VERIFICATION

3.1 Preamble

The Commission's decision to request the execution of an Article 35 verification was notified to the Swedish Permanent Representation to the European Union by letter TREN.H4 CG/cd D(2008) 438119 dated 28 October 2008.

Subsequently, practical arrangements for the implementation of the verification were made through contacts with the Swedish Radiation Safety Authority (SSM).

3.2 Programme of the visit

A preliminary programme of verification activities under the terms of Article 35 of the Euratom Treaty was discussed and agreed upon with the Swedish competent authorities.

The programme encompassed verifications of discharge monitoring at Forsmark NPP, environmental monitoring in the vicinity of the NPP and selected parts of the Swedish national environmental radioactivity monitoring programme.

The verifications were carried out in accordance with the programme, a summary overview of which is attached as Appendix 2 to this report.

3.3 Documentation

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

3.4 Representatives of the competent authorities and the operator

During the verification visit, the following representatives of the national authorities and the operator were met:

Ministry of the Environment, Stockholm

Ansi Gerhardsson	Deputy Director, Ministry of Environment

SSM Stockholm

Carl-Magnus Larsson	Head of Department of Radioactive Materials
Lynn Hubbard	Head of Section, Emergency Preparedness
Maria Lüning	Analyst, Environmental Control
Inger Östergren	Laboratory engineer
Lena Wallberg	Laboratory engineer
Christer Karlsson	Site Inspector, Forsmark
Ann-Christin Hägg	Analyst, Discharges
Simon Karlsson	Analyst, Emergency Preparedness
Jonas Lindgren	Analyst, Emergency Preparedness
Birgitta Ekström	Inspector, Forsmark
Johanna Sandwall	Head of Section, Operation and Decommissioning of Nuclear Facilities

Helene Asp	Head of Section, Environmental Assessment
Pål Andersson	Analyst, Environmental Assessment

Forsmark NPP

Staffan Hennigor	Radiation Protection Manager
Erika Bohl Kullberg	Specialist in Radiology
Mattias Olsson	Specialist in Radiochemistry
Erik Kjellgren	Group Manager
Charlotte Lager	Chemist
Jan Ola Helmersson	Group Manager
Maria Berglund	Chemist
Anette Grundin	Chemist
Felix Kuffner	Group Manager Radiophysics
Tomas Larsson	Manager Waste Department
Lena Eriksson	Engineer Waste Management

FOI Stockholm

Karina Lind

SGU Uppsala

Sören Byström	Senior Advisor Airborne Geophysics

4 LEGISLATION AND COMPETENT AUTHORITIES

4.1 Primary legislation and derived regulations

The legal framework in the field of environmental radioactivity monitoring is to be found in the Radiation Protection Act (SFS 1988:220), which aims to protect people, animals and the environment from the harmful effects of radiation, and in the Environmental Code (SFS 1998:808), which addresses environmental aspects of nuclear activities and lists nuclear activities among several other “environmentally hazardous activities”. The Swedish Parliament has appointed the SSM to implement its environmental quality objective, *Säker strålmiljö* (Safe Radiation Environment).

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 of concern 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.

Human health and the environment shall be protected from the harmful effects of ionizing radiation both during the operation of a nuclear facility as well as in the future. Releases of radioactive substances may not lead to more severe impacts on human health and the environment beyond Swedish borders than is accepted within Sweden.

The limitation of releases of radioactive substances from nuclear facilities shall be based on the optimization of radiation protection and achieved by using the best available technique (BAT). The optimization of radiation protection shall include all facilities located within the same geographically delimited area. The possibility that radiation doses to the personnel can increase when releases to the environment are limited shall be taken into account during the optimization as shall the consequences of other waste management alternatives.

The effective dose to an individual in the critical group of 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 includes the dose from external irradiation and the committed effective dose from internal irradiation, shall be integrated 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 in the 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 within the most affected area for the period concerned.

The basis for the dose calculations and the methodology used to calculate the relationship between released activity and effective dose shall be presented to the SSM for examination. The reference values shall be established for each nuclear power reactor with respect to annual released activity of individual radioactive substances or groups of radioactive substances. The reference values shall be worked out by the licensees and submitted to the SSM for examination. The basis for the proposed reference values shall be attached to the notification.

Target values shall be established for each nuclear power reactor with respect to the release of individual radioactive substances or groups of radioactive substances and shall show the level to which the releases can be reduced over a specific period.

Quality assurance and documentation of environmental surveillance shall be provided in accordance with the principles of ISO 9000. The laboratories used for the environmental surveillance shall, at the request of the SSM, participate in comparative measurements (inter calibrations).

For nuclear power reactors, plans of action shall exist to limit the release of radioactive substances that can arise in the event of fuel failures. The strategy for avoiding the occurrence of fuel failures and the measures planned to limit radioactive releases to the environment in the event of a fuel failure shall be described in the plans.

In the event of a release of radioactive substances to air or water, which results in a dose to any individual in the critical group exceeding 0.01 mSv per month or if results from environmental monitoring show abnormally large quantities of radioactive substances, the SSM shall be notified as soon as possible.

Before new facilities are brought into operation or the operational conditions are modified so that new release pathways or new release sources arise, or an existing release pathway is modified, investigations shall be conducted to determine the size and composition of the release, the environmental and dispersion conditions as well as expected doses. These investigations shall be submitted to the SSM for examination.

4.2 Environmental radioactivity monitoring

The following legal texts cover the statutory requirements for environmental radioactivity monitoring:

- The Swedish Radiation Protection Authority's Regulations on the Protection of Human Health and the Environment from the releases of Radioactive Substances from Certain Nuclear Facilities (*SSI FS 2000:12)*
- 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*

Environmental monitoring shall be conducted in the surrounding areas of nuclear facilities in accordance with programmes formulated by the SSM. The programmes contain regulations for sampling, sample preparation, analysis, evaluation and reporting as well as information on the type of samples and sample locations.

At the request of the SSM, separate environmental monitoring shall be conducted and the environmental consequences to the most affected area assessed, for all events resulting in an increased release of radioactive substances to the environment. Continuous measurements of gamma radiation shall be conducted in the environment around nuclear power reactors, research reactors and material testing reactors. Measurements shall be conducted on land at a distance of about one kilometre from the facility.

Meteorological conditions at nuclear power reactor, research reactor and material testing reactor sites shall be continuously recorded.

4.3 Radiological surveillance of foodstuffs

The following legal texts cover the statutory requirements for foodstuffs radioactivity monitoring:

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

4.4 Discharge monitoring

The following legal texts cover the statutory requirements for discharge monitoring:

- The Swedish Radiation Protection Authority's Regulations on the Protection of Human Health and the Environment from the releases of Radioactive Substances from Certain Nuclear Facilities (*SSI FS 2000:12)*
- EU Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation

Releases of radioactive substances from a nuclear facility to the air and water shall be controlled through measurements. The detection limits of the measuring instruments shall be selected so that the effective dose can be estimated for an individual in the critical group.

Releases to the air via the main stacks of nuclear power reactors, research and material testing reactors shall be controlled through continuous nuclide-specific measurements of volatile radioactive substances such as noble gases, through nuclide-specific measurements of continuously collected samples of iodine and particle-bound radioactive substances as well as through the measurement of Carbon-14 and Tritium.

Releases to the air from a facility for fabrication of uranium pellets and nuclear fuel bundles, for storage or other handling of spent nuclear fuel, and for storage, handling or final disposal of nuclear material or nuclear waste shall be controlled through nuclide-specific measurements of particle-bound radioactive substances in continuously collected samples and, where relevant, Iodine and Tritium.

Releases to water shall be controlled through the measurement of representative samples for each release pathway. The analyses shall include nuclide-specific measurements of gamma and alpha-emitting radioactive substances as well as, where relevant, Strontium-90 and Tritium. The SSM conducts control measurements on representative water samples from each pathway from the month before and after the outage period. The samples are analysed for gamma radiation.

Representative annual samples of releases to water from nuclear power, research or material testing reactors shall be submitted to SSM within three months after the end of the release year. The samples are analysed for nuclide-specific gamma and for tritium. The functioning of measuring equipment and release-limiting systems shall be regularly controlled and also in the event of any suspicion of a malfunction. Written instructions shall exist for the maintenance of the equipment. Any modification of regular systems for the monitoring of releases shall be approved in advance by the SSM.

Measuring and sampling equipment for the control of releases to air may be out of order for a period not exceeding 24 hours for maintenance or in the event of a malfunction without any special permission from the SSM. If the measuring equipment is out of order for a longer period of time, operation may continue, during non-office hours, until the Swedish Radiation Protection Authority has been contacted, on condition that the operation can be expected to be stable from the standpoint of releases. The reasons upon which this assessment was made shall be reported when the SSM is contacted. When the regular measuring equipment is out of order, other monitoring systems shall be used, to an adequate extent, in order to determine the released activity.

The measuring equipment may only be shut down, for other reasons, after special permission has been obtained from the SSM. The nuclear power reactor coolant shall be analyzed. The analyses shall include nuclide specific measurements of gamma and alpha-emitting radioactive substances as well as Strontium-90 and Tritium. If the possibility of diffuse leakage of radioactive substances is suspected, and it is not possible to determine such leakage by measurements, an investigation shall be conducted to determine an upper boundary for possible undetectable leakage to air and water from the facility.

4.5 Competent authorities

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 responsibilities 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 SSM to implement its environmental quality objective *Säker Strålmiljö* (Safe Radiation Environment).

According to the Radiation Protection Ordinance (SFS 1988:293) SSM has the mandate to issue regulations in the field of radiation protection including environmental monitoring and discharge control. The SSM Regulations on the Protection of Human Health and the Environment from the releases of Radioactive Substances from Certain Nuclear Facilities (*SSI FS 2000:12*) include provisions on environmental monitoring in the vicinity of nuclear facilities. The environmental monitoring programme has been issued by the SSI (latest version, SSI report 2004:15, valid from 1st of January 2005). It specifies types of sampling, sample treatment, radionuclides to be measured, reporting, etc. Every year a basic programme involving spring and autumn sampling is conducted. Furthermore, certain samples are taken on a monthly and quarterly basis. In addition to the basic programme, extended sampling is also conducted every fourth year at most of the facilities. The extended programme focuses exclusively on samples taken in the marine environment.

National Board of Fisheries conducts the sampling of environmental samples outside the facilities. The samples are analysed by the facilities themselves or at an external laboratory.

National Defence Research Agency (FOI) operates a national air sampling network to detect particulate radionuclides in the air.

National Food Administration (NFA) is the central supervisory authority for matters relating to food. It 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 includes also radioactive contaminants in food. Food control at the local level is the responsibility of the relevant municipal committee(s), usually the Environment and Health Protection Committee. County administrations are responsible for co-ordinating food control within each county.

Swedish Geological Survey (SGU) carries out airborne radiation monitoring.

5 MONITORING OF FORSMARK NPP RADIOACTIVE DISCHARGES

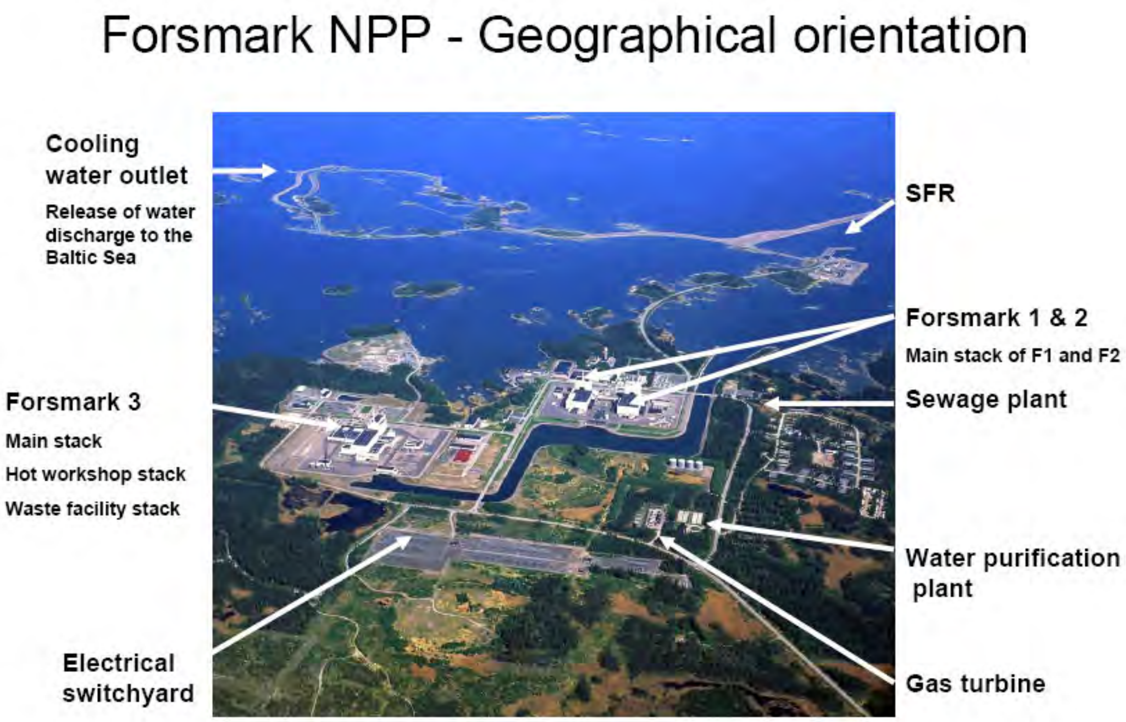
5.1 General description of the Forsmark NPP

Forsmark nuclear power plant is situated on the Swedish east coast about 4 km north of Forsmarks Bruk in Östhammar Municipality in Uppsala County. It is situated on the coastline of the Baltic Sea and uses sea water for cooling. The immediate surroundings with the villages Öregrund, Östhammar, Österbybruk, Gimo and Tierp are sparsely populated but the distance to large consumers of electricity such as the larger cities, Gävle, Uppsala and the whole Stockholm area is relatively short.

Discharges from the Forsmark NPP are mainly to the Baltic Sea. To study the effects of releasing heated cooling water into the sea an artificial “atoll”, the Biotest Lake, has been constructed.

The plant consists of three nuclear power units, all of which are boiling water reactors (BWR). The power plant’s industrial area also houses storage and workshop buildings necessary for the most common repair and maintenance work. Figure 1 provides an aerial picture of the Forsmark NPP area.

Figure 1. Forsmark NPP



The three nuclear power units were all designed by the former ASEA-ATOM (currently Westinghouse Electric). Construction of Forsmark 1 and 2 (F1, F2) started in 1971 and 1973 and they were put into commercial operation in 1980 and 1981 respectively. They currently have a net output of 1010 MWe each. The reactors produce saturated steam with a pressure of 7 MPa for direct use in the steam turbines (two turbine trains per reactor). The fuel in the reactor core is enriched uranium dioxide. The maximal thermal output in each unit is 2928 MW. Since the reactors have internal circulation pumps and fine motion control rods they are considered to be an early advanced boiling water design.

Forsmark 3 (F3) is similar to F1 and F2, although unit 3 has only one turbine train. Construction of the unit started in 1978 and it was put into commercial operation in 1985. Another difference between F1/F2 and F3 is that the latter is designed to withstand seismic events far greater than those foreseen to occur in Scandinavia. The physical separation is also more advanced. F3 has 700 fuel assemblies (676 in F1 and F2), which generate a nominal thermal output of 3300 MW. F3 currently has a net output of 1190 MWe.

Forsmark reactors produce close to 25 TWh per year, which is about one sixth of the Swedish electricity production. During the verification visit all units at the Forsmark site were in commercial operation.

A disposal site for low and intermediate level waste (SFR) is located in close vicinity to the Forsmark site. The license holder for the SFR facility is the Swedish Nuclear Fuel and Waste Management Co. (SKB) but the facility is operated by FKA. Discharges from the SFR-facility are regulated in the regulation of discharges from nuclear installations and included in the total discharges from the Forsmark site.

The Forsmark site also includes a shallow land burial site for short-lived very low level waste.

5.2 Regulatory limits for gaseous and liquid discharges

5.2.1 Description

SSM has not defined any radionuclide specific discharge limits. Limitation of releases is being implemented through the restriction of dose to the critical group members [3]. For each nuclear facility, e.g. each reactor at Forsmark, and for each radionuclide that may be released, specific release-to-dose factors have been calculated. The factors have been calculated for hypothetical critical groups, and take into consideration local dispersion conditions in the air and in the environment, local settlements, locally produced food as well as moderately conservative assumptions on diet and contribution of locally produced foodstuffs to the diet of the group. The latest release-to-dose factors are based on more realistic assumptions than earlier ones and are in line with the requirements in the EU BSS.

For nuclear power reactors, release-to-dose factors (mSv/Bq) have been calculated according to the Appendix III of the Council Directive 96/29/Euratom for 97 radionuclides that may be discharged to the marine environment and 159 radionuclides that may be emitted to air. The dose contributions from all monitored radionuclides are summed, and this sum shall not exceed 0.1 mSv for a calendar year. Facilities are required to notify SSM of any abnormal releases or if the dose limit of 0.01 mSv/month to any individual is exceeded.

Nuclear power plants are required to report to SSM on a regular basis the releases to air and water and the estimated doses to individuals.

5.2.2 Verifications

The verification team verified the regulations concerning the regulatory limits for gaseous and liquid discharges and noted the following:

- There appears to be no formalised policy for reporting values below MDA in Sweden and there has been no regulatory guidance on the required instrument sensitivity. In Forsmark the policy is to report zero if the measured value is below the MDA of the system.

Verification team recommends that SSM considers the benefits of revising its regulatory requirements for substitutions of analytical results below MDA by bringing these requirements in line with the Commission Recommendation 2004/2/Euratom and ISO standard 11929-7:2005.

5.3 Monitoring and sampling provisions for gaseous discharges

5.3.1 System description

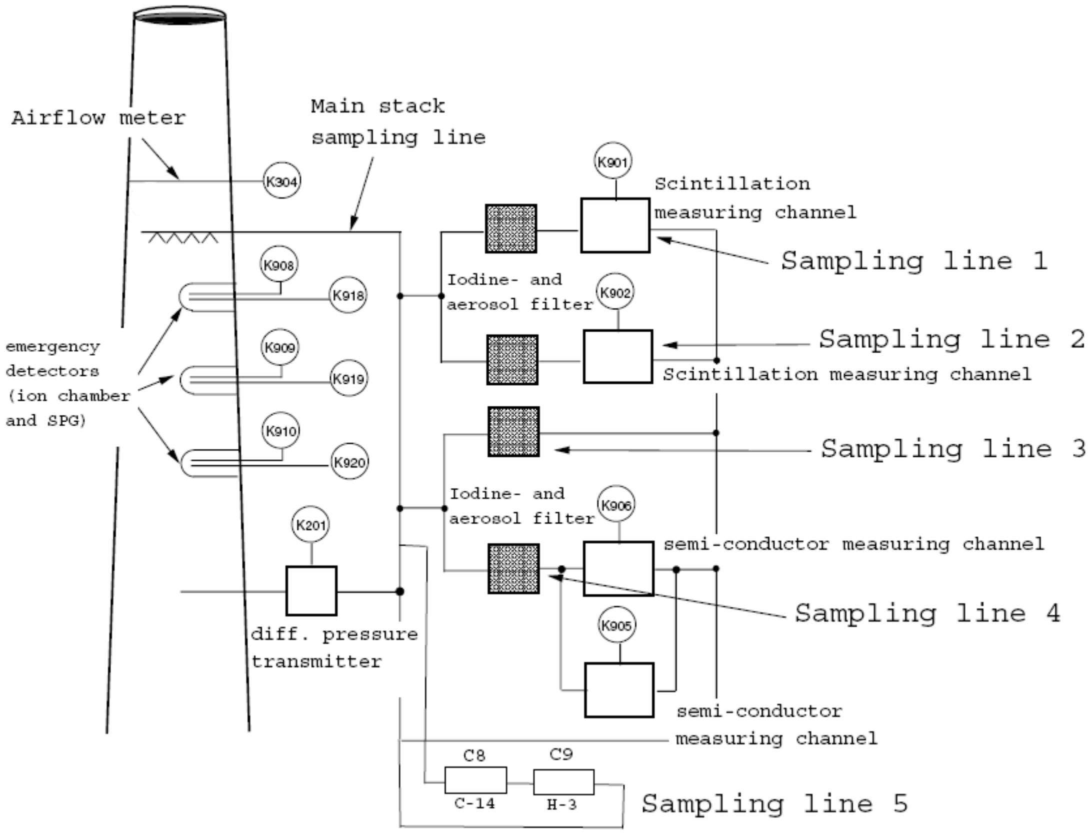
Allowed release points at Forsmark site for gaseous discharges are unit main stacks (3), waste building ventilation stacks (1), hot work-shop stack (1) and the emergency filter building stacks (3).

Main stack monitoring

Discharge from the main exhaust stacks is controlled by on-line measurements of total radioactivity, nuclide-specific on-line monitoring of noble gases and continuous sampling of aerosol particles and iodine. Also C-14 and tritium are continuously sampled.

From the main stack of each unit an isokinetic partial flow is directed proportionally through five parallel sampling lines (Figure 2). For each sampling line calibrated gas flow meters are used to determine the flow volume. Readings are recorded on each filter change to calculate the total filter flow volume. The total flow in the stack is measured using an annubar probe inside the stack that registers the difference between the static and dynamic pressure. The value is transmitted to the plant central computer system.

Figure 2. Main stack discharge monitoring



Sampling lines 1 and 2

Sampling lines 1 and 2 are used for collection of aerosols and iodine using combination filters (glass fibre filter attached to a carbon filter cartridge). The filters are changed and evaluated for gamma nuclides once a week (line 1) or once a month (line 2). The collected activity in the filters is continuously monitored by GM-detectors. If high values are measured sampling line 3 starts automatically.

The samples are to be evaluated within 24 hours after filter removal. At evaluation the results are corrected for decay during the sampling period. The filters are separated into the aerosol collecting part (glass fibre filter) and the iodine collecting part (carbon filter) before measurement on germanium detectors. The aerosol filters changed every month (line 2 or line 4) are also used for determination of Sr-90 and nuclide specific alpha. These measurements are done every 6 months on composite batch samples.

To get a continuous measurement of the total gamma activity discharge air is led into measuring chambers with NaI(Tl) detectors after the aerosol and iodine filters. Count rate values from these detectors are continuously displayed in the control room. The detector stability is continuously monitored using an attached check source. The computer system gives an alarm if the count rate values are too high or too low.

If the total activity measurement malfunctions, readouts from the nuclide specific measurement should be taken every hour or manual air samples should be taken every other hour for analysis in the laboratory. If the sampling for iodine and aerosols is malfunctioning, manual air samples should be taken within one day.

Sampling line 3

This line is an extra line intended for future needs. It is supplied with particle- and iodine filters and can be used if the sampling in line 1 or 2 is malfunctioning.

Sampling line 4

In this line the discharge is continuously evaluated for noble gas content by nuclide specific gamma measurements using germanium detectors after having passed filters that remove aerosols and iodine that otherwise would have interfered with the measurements. The on-line gamma detector evaluates the data every 6 hours. There are two electrically cooled HPGe-detectors, (553K905, 553K906) on F1 and F2 and two nitrogen cooled HPGE- detectors (553KB741, 553 KD742) on F3. The two detectors at each reactor have separate electronics and computer systems. They are both running in parallel giving redundancy to the monitoring system. If the nuclide specific measurement is out of order (the total activity measurement is running) manual air samples should be taken once every 24 hours. This should be noted in the reports and the results should be calculated conservatively.

Sampling line 5

The flow in this line is led through sampling equipment that collects C-14 and H-3. C-14 is continuously collected in NaOH and H-3 is continuously collected in water (MARC 7000 Tritium sampler and HAGUE 7000 Carbon sampler). Every fortnight the samples are changed and after a couple of days (decay time for short lived nuclides) they are measured using a liquid scintillation counter. If the C-14 and H-3 sampling is not working, there should be a stand-in measurement system operating within 7 days.

Main stack emergency monitoring

For emergency monitoring purposes there are detectors in the main stack that are able to measure higher doses than the on-line HPGe- and NaI-detectors. An ion-chamber and a Self Powered Gamma (SPG) - detector is connected to the control room for on-line continuous monitoring. To ensure that the detectors are working they are equipped with a Cs-137 background source. The systems will give an alarm when the signal is too low indicating that the systems might malfunction, or too high indicating an emission of radioactivity. These systems are able to cover a very wide dose rate range (10 – 10^6 Gy/h).

Emergency filter building stack monitoring

In case of a major emergency pressure release, steam from the containment can be led through an emergency filter (FRISK-system [1]) and vented to the atmosphere through the emergency filter building stack. The release through this stack is monitored with an on-line ionisation chamber and aerosol and iodine filters. Monitor readings are available locally and at the control room. There are alarms for high and low readings. The filters are changed annually.

Condenser off-gas monitoring system

Apart from the actual discharge monitoring Forsmark NPP has developed a system for monitoring gaseous activity in the condenser off-gas system in order to detect and locate possible fuel failures as early as possible. The system is based on three NaI-detectors and one electrically cooled HPGe detector. The NaI detectors monitor the total off-gas activity and the HPGe system collects the gamma spectrum of the condenser off-gas on 20 minute cycles for qualitative analysis. Spectrum data is analysed on weekly basis.

Monitoring at the waste handling facility

The exhaust stacks at Forsmark 3 waste handling facility and the hot workshop are monitored by having a partial flow pass through filters that collect aerosols and iodine. The filters are changed and measured weekly. The filters are continuously monitored using NaI-detectors and an alarm will go off if the activity concentration in the filters becomes too high.

5.3.2 Verifications

Verification team verified the following gaseous monitoring arrangements at F2:

- Noble gas monitoring computers located at the control room area. Two redundant systems collect the on-line data from the stack monitors, perform spectral analysis at 6 hour intervals and store the results into the plant database.
- Stack monitor display systems available at the operator panels in the control room (activity and airflow). Here the system stores the results on memory cards, which are archived for verification purposes. Alerts on high values are available at the plant control system.
- Condenser off-gas monitoring system
- Emergency filter building monitoring systems
- Main stack on-line monitoring systems
- Main stack off-line monitoring systems
- Main stack emergency monitoring system

Based on the verifications the team noted the following:

- The gaseous discharge monitoring system at F2 is very sophisticated, well equipped and adequately maintained. It appears to adequately meet the gaseous discharge monitoring requirements both in routine and emergency situations.

  Verification does not give rise to recommendations.

5.4 Monitoring and sampling provisions for liquid discharges

5.4.1 System description

At the Forsmark waste treatment facilities, radioactive waste water is collected in special tanks. The waste water is purified by an evaporator which gives almost pure water with most of the activity collected in a concentrate that is deposited in rock caverns of the underground repository SFR.

Water discharge is released to the cooling water outlet from F1 and F2 release tanks (00-342 T62/T64 and 30-342 TC61/TC62). Prior to release of water into the recipient a non-statutory pre-sample is taken and measured to control that the radioactivity is sufficiently low. For F1 and F2 this is done using a one litre sample flask on a 3” NaI-detector. At F3 the pre-samples are measured using a HPGe-detector. If the pre-sample indicates too high activity values the tank contents are redirected to the purification system (the verification team was informed that this has not happened for several years). The waste water release valves are normally locked closed. A key is provided by the shift manager after the tank activity has been confirmed to be below the activity limit.

During the discharge a proportional part (1/10000) of released water is collected in a special tank. The water from this sampling tank is analysed each month with regard to nuclide specific gamma emitters. Samples are filtered through a glass fibre filter. The particle fraction (on the filter) and the water fraction are measured separately. Water is distilled before measurement of H-3 and 20 ml water is evaporated to measure total alpha. From each monthly sample a part is acidified by HNO_3 and kept to form a weighted 6 months batch sample which is used for evaporation in order to carry out nuclide specific alpha analysis and phase separation for Sr-90 analysis.

As an extra security measure, on-line NaI-detectors monitor the pipes during discharge. If the dose rate is too high the valves close automatically and the water release stops. This measurement is connected to the central control room but the results are not used for statutory reporting.

Representative monthly samples (two from F1/2 waste facility and two from F3) are taken one month before the outage period and one month after the outage has ended. The samples are sent in to the SSM within two months after the monitored discharge month's end.

Representative annual samples of discharged water (for each release point) are sent to SSM within three months after the end of the year.

5.4.2 Verifications

Verification team verified the following liquid discharge monitoring arrangements at F3:

- Control room monitoring arrangements
- Arrangements at the statutory sampling station at the waste water treatment facility
- Arrangements at the waste water tank pre-sampling station at the waste water treatment facility
- Locking of the main release valves

Based on the verification the team noted the following:

- The arrangements for taking the statutory liquid discharge sample are sophisticated and well built. They appear to adequately meet the sampling requirements.

However,

- At the statutory sampling station the tank rinsing line valve is not locked. Opening this valve (346 VC16.V1) could accidentally dilute the statutory sample collected in the tank.
- There was no sampling instruction available at the release tank pre-sampling station.

  Verification team recommends making sure there is no possibility of accidental dilution of the contents of the statutory release sample.

  Verification team recommends making sure there is a written sampling instruction available at each sampling station.

5.5 Forsmark 3 discharge monitoring laboratory

5.5.1 Description

F3 analytical laboratory carries out the measurements of the plant discharge samples. The laboratory is well equipped and adequately staffed, but not accredited. It has two HPGe detectors (Canberra) for gamma spectroscopy and one Liquid Scintillation counter (Tri-Carb 2900TR) for C-14 and H-3 analysis. Statutory discharge samples are kept in a locked sample archive.

The laboratory participates in IAEA and joint Swedish-Finnish round-robin inter comparison exercises on a regular basis.

5.5.2 Verifications

Verification team verified the following analytical arrangements for discharge monitoring at the F3 laboratory:

- Sample preparation arrangements
- Counting room arrangements
- Sample archiving arrangements

Based on the verification the team noted the following:

- The laboratory is well staffed and equipped and therefore fully able to carry out its analytical tasks.

However,

- The laboratory has a control routine for HPGe detector stability (energy, efficiency and peak FWHM). It was noted that the efficiency stability test indicated unusually large variations in the BRAD detector efficiency.

Verification team recommends making sure the HPGe-detector efficiency stability test procedure at the F3 laboratory is adequate and the stability of each detector is thoroughly controlled.

5.6 Forsmark 1/2 discharge monitoring laboratory

5.6.1 Description

Forsmark 1/2 analytical laboratory carries out the measurements of the gaseous and liquid radioactivity discharge monitoring programme (liquid pre-samples, statutory samples, stack filters, condenser off-gas filters and gaseous samples) from units F1 and F2. The laboratory is in charge of maintaining the monitoring equipment located at the plants.

The laboratory has three HPGe gamma detectors (2 Canberra, 1 Nuclear Data) for gamma spectroscopy and one liquid scintillation counter (Tri-Carb 2900 TR) for total alpha/beta measurements. In addition the laboratory has two old alpha counters (Canberra and Tennelec), which are currently being replaced by a new system (Canberra α-Analyst). The laboratory has also portable gamma spectroscopy systems.

5.6.2 Verifications

Verification team verified the following analytical arrangements for discharge monitoring at the laboratory:

- Sample preparation arrangements
- Counting room arrangements
- Sample archiving arrangements

In addition special attention was paid to the changes implemented after the gaseous discharge monitoring incident, which took place at F1 in 2006. The verification team was informed, that after the incident a filter cross-checking procedure was put in place in all the Swedish NPPs. This procedure together with a new procedure for filter colour control should allow the laboratory personnel to detect any filter by-pass flow affecting the measurement results.

Based on the verification the team noted the following:

- The laboratory is well staffed and equipped and therefore fully able to carry out its analytical tasks.
- Corrective action has been taken in order to avoid the monitoring deficiencies encountered in 2006. It should be also acknowledged that these corrective actions have been implemented also in other Swedish NPPs.

Verification does not give rise to recommendations.

6 ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

6.1 Forsmark NPP environment monitoring programme

6.1.1 Description

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

The regulations [SSI FS 2000:12] include provisions on environmental monitoring. The environmental monitoring programme is issued by the SSM (latest version, SSI report 2004:15, valid from 1st of January 2005) and specifies type of sampling, sample treatment, radionuclides to be measured, reporting, etc. The site-specific monitoring programmes vary depending on the facility and are divided into a terrestrial and an aquatic part. The selection of environmental samples (biota and sediments) has been conducted in order to be 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 basic programme involving spring and autumn sampling is conducted. Furthermore, certain samples are taken on a monthly and quarterly basis. In addition to the basic programme, extended sampling is conducted every fourth year at most of the facilities. The extended programme focuses exclusively on samples taken in the marine environment. The National Board of Fisheries conducts the sampling of environmental samples from 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 programme, SSM conducts inspections and takes random sub-samples for measurements at the SSM or at independent laboratories.

Discharges from Forsmark are mainly to the Baltic Sea; therefore the water environment is thoroughly monitored with samples from various water living organisms from a large number of sampling sites. There are in total 27 sampling sites within 13 km from the plant. The land environment is also closely monitored: soil, vegetation and sludge are sampled as well as human foodstuffs such as milk, meat, vegetables and grain. There are 10 sampling sites for the land environment (excluding dosimeter sites (23 TLD's)), all within 12 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 to growth and reproduction occur.

The environmental control programme consists of two parts: an annual base programme and an extended programme performed every four years. The base programme makes it possible to detect short-term trends and covers a larger geographic area. Tables I-III summarise the content of the two programmes.

Table I Forsmark NPP water environment base programme

Sample type	Number of stations	Frequency	Number of samples	Number of samples / year
Diatomic algae	3	Monthly	1	36
Sediment	3	Quarterly/(autumn)	1	9
Algae	5	Autumn	1	5
Molluscs	4	Autumn	3	4
Fish	3	Spring/Autumn	4	9

Table II Forsmark NPP water environment extended programme

Sample type	Number of stations	Frequency	Number of sample types	Number of samples /4 year period
Algae	6	Each fourth year	3	10
Molluscs	8	-”-	3	9
Sediment	11	-”-	1	11

Table III Forsmark NPP land environment base programme

Sample type	Number of stations	Frequency	Number of samples	Number of samples / year
Natural vegetation	7	Spring/ Autumn	5	17
Cultivated vegetation	3	July+ Autumn	5	7
Animal samples	1	Autumn	1	1
Milk	1	Each fortnight (pasture season)	1	10-14
Sludge	4	Autumn	1	4
Dose measurements (TLD)	23	Quarterly		92

The National Board of Fisheries delivers most of the samples; staff from Forsmark picks up the milk samples at a nearby farm.

All radioactivity measurements are performed on dry materials. Most samples are burnt into ashes in ovens and thereafter measured in established geometries on germanium detectors in the laboratory for environmental samples.

Water sampling of the plant foundation drainage collection system is performed once a month. To verify that the drainage systems for each unit have not been contaminated, sludge samples are removed from pump holes every year after the outage period. The sludge is measured by nuclide specific gamma analysis.

For continuous evaluation of the gamma radiation in the vicinity, 23 TL-dosimeters (LiF-700) placed in little red boxes are placed within a radius of about one km from the plant. These are changed and evaluated quarterly.

Seven short link Gammatracer probes (Genitron Instruments operated with their own battery) are mounted in the surroundings and continuously monitor the dose rates. There is one mobile unit as well to be used in an emergency situation. The probes send data to the water tower where the signals are gathered and displayed in the Genitron software, accessible from computers at the plant. The system is intended for use in emergencies, not during normal operation. The batteries typically last for five years at normal background levels. GammaTracer has a built-in quality assurance system which continuously compares the two GM detectors to ensure that they are consistent and verifies other operating parameters. Any irregularity is logged in the probe's memory and flagged by a marker in the displayed area, once this is downloaded. The nature of the irregularity can then be investigated by the user.

6.1.2 Emergency monitoring arrangements

An emergency room is located on site where different equipment is kept for use in case of emergency. The monitoring equipment consists of one mobile short link Gammatracer unit (Genitron) and 4 portable air pumps with petrol engines for air sampling. There are also two personnel monitors to be used by the cleaning staff (for example). The room is locked and one key is kept in the emergency centre and another by the duty officer. A specific trailer would be used in case of emergency to pick up the equipment operated by the rescue team.

To be able to warn the staff in emergency situations dose rate monitors have been installed in the main entrance, security centre and the switchboard room as well as in the control room of each unit. Mobile units are placed at nine assembly points in an emergency situation. The detectors are Automess Gamma-Alarm-Station 859.1 with a battery backup. They are calibrated annually and their function is tested once every six months with a known source. Calibration and functionality testing is documented in a log-book.

6.1.3 Meteorological station

The meteorological station consists of a meteorology tower about 1 km from the plant. There are measuring points for temperature at 2, 8, 24 and 100 m heights. The temperature difference between different heights is given for points above 2 m. Wind speed and direction are measured at 25, 50 and 100 m. Measurement data is transferred to a server in the emergency centre where it is processed using the Airviro computer system (SMHI, Sweden). Data can be reached through a web based application from every computer 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.

6.1.4 Forsmark NPP environmental monitoring laboratory

The environment monitoring laboratory is located outside the controlled area. It has separate rooms for sample preparation and measurements of radioactivity. In the laboratory there are 2 HPGe-detectors (Canberra and Enertec). In case of emergency, this equipment can be taken out and used in the field.

Sample reception: sample identification and registration procedure

Deep frozen samples are received from the coastal laboratory in Öregrund, an independent agency. Most of the samples are already prepared. Upon reception, they are recorded in a binder and labelled with sampling information (date, type, station, sample collector, possible remarks).

Sample preparation and measurement

Samples are dried in two clay ovens at 80°C (except on-growth samples). When dried, samples are weighed and burnt into ashes in two other ovens at a maximum of 430°C. One oven is new and was being tested at the time of the verification. Ashes are then compacted and put into boxes labelled with sample date; this label information is cross-checked with the database. Samples are then measured for 80.000 sec on one of the HPGe-detectors and analysed with regard to the following radionuclides: 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, this being the standard list of nuclides for analyses. Other nuclides are on the print-out of the measurement results.

Values are recorded on paper and stored in an interim fireproof archive for 18 months before being transferred to the central archive. Final results for each sample are filed both on paper and in the database.

Reporting obligations

Report on detected nuclides is sent to SSM in six month and annual reports with set parameters. The safety and environment department is responsible for sending reports to SSM. Every instruction for analysing nuclides is under the control of SSM. The laboratory is audited internally and externally (by SSM, IAEA OSART mission and WANO) on a three year basis.

Double samples on several sample types are gathered and sent to the SSM for independent analysis, thus allowing a double check sampling system.

Archiving

Written instructions are available for the staff on how to handle and archive samples. Treated samples are kept in an interim storage for 18 months before being transferred to the central archive for at least 10 years storage. Milk samples are freeze dried in a LABCONCO machine for storage. During the verification visit the main archive room was being modernized.

6.1.5 Verifications

The verification team verified the following arrangements of the environmental monitoring programme in place at Forsmark NPP:

- Overall structure of the programme
- Measurement equipment of the environment laboratory
- Sample preparation, measurement, reporting and archiving procedures at the laboratory
- Sampling of the Baltic sea water environment
- Site emergency room and the instruments ready for use in case of emergency
- Availability and distribution of the data collected by the weather station

The verification team noted that:

- Forsmark NPP environment programme is comprehensive and well implemented. The only remark is that the programme does not include monitoring of rain water radioactivity.
- The environment laboratory is well equipped and staffed, but has no formal accreditation.
- The laboratory database is user-friendly and shows records of analysed samples back to 1976 (3.600 samples).

The verification team suggests considering implementation of a rain water radioactivity monitoring programme.

The verification team suggests that the environment laboratory proceeds towards a formal accreditation.

6.2 National environment radioactivity monitoring programme

6.2.1 Introduction

SSM has implemented a national environmental radioactivity monitoring programme outlined in Table IV.

Table IV. National environmental monitoring programme overview

	Nuclides	Number of samples	Comments	Involved organisations
National monitoring				
Particles in air	γ (^{137}Cs, ^{7}Be)	5 stations	Weekly	FOI, SSM
Surface water	^{137}Cs, total-α, total-β, ^{234,238}U, ^{226}Ra	2 water plants	Spring and autumn	SSM
Drinking water	^{137}Cs, ^{90}Sr, ^{3}H, total-α, total-β, ^{234,238}U, ^{226}Ra	6 water plants	Spring and autumn	SSM
Consumption Milk	γ (^{137}Cs), ^{90}Sr	5 dairies	4 times/year	SSM
Mixed diet	γ (^{137}Cs), ^{90}Sr	3 hospitals	Spring and autumn	SSM
Game meat (moose and roe deer)	γ (^{137}Cs)	2 areas	Yearly	SLU, Gävle jaktvårdkrets, SSM
Reindeer meat	γ (^{137}Cs)	32 villages	Varying extent in different villages	SJV, SLV
Marine sediments open sea	γ (^{137}Cs)	16 stations	Every 5th year	SSM
Marine fish	γ (^{137}Cs)	8 areas	Yearly	SSM
Sea water	γ (^{137}Cs)	6 stations	Yearly	SSM
Regional monitoring				
Some municipalities have their own programs or offer the citizens to analyse their own samples of mainly game meat, mushrooms, fish, and berries.	γ (^{137}Cs)		In many occasions rather a service to citizens than a proper monitoring program. Some data are available through web site of SSM.	

Local monitoring				
Recipient control around nuclear sites. Precipitation, natural vegetation, cultured vegetation, meat, milk, sewage sludge, water, sediment, algae, molluscs, crustaceans, fish.	γ (^{54}Mn, ^{58}Co, ^{60}Co, ^{65}Zn, ^{110m}Ag, ^{137}Cs), ^{234}U, ^{235}U, ^{238}U (only Westinghouse site)	In total 184 sampling stations on six sites	Sampling frequency between once a fortnight and once a year plus an extended program every forth year.	Nuclear facilities and SSM
Mapping projects				
Agricultural soils and crops	γ (^{137}Cs)	1250 locations	2001-2010	NV, SLU, SSM
Airborne mapping of ground radiation	γ (^{137}Cs, K, U, Th)	surface covering	ongoing	SGU, SSM

6.2.2 External gamma dose rate monitoring

Sweden has an automatic network of 32 fixed gamma monitoring stations throughout the country. The main purpose of the network is to give an alarm if there is a significant increase above the natural background gamma radiation level and to give an instant overall picture of the radiation situation in Sweden.

The network is old and in need of modernisation. 28 new gamma monitoring stations will be installed among the existing weather stations in collaboration with the Swedish Meteorological and Hydrological Institute (SMHI). It is planned to use the old and new networks together for about 6 months. (Up to May 2009, 9 new stations have been installed.)

The measuring device of the old network consists of a pressurised ionisation chamber with a measuring range of 1-600 000 nSv/h ambient dose equivalent rate. The average normal background level in Sweden is 100-150 nSv/h. The results are stored locally on a microcomputer, which is equipped with a modem. There is also a local data display. The main computer in SSM in Stockholm calls each gamma station over the public network 12 times per day to collect data. The microcomputer at each station is equipped with an alarm function, which is triggered on a pre-set alarm criterion. The dose rate is continuously integrated over a twenty-four-hour rolling period. The alarm criterion is an integrated dose rate of 300 nSv/h above the preceding 24 hour average.

The system has shown a high degree of reliability which is important since many of the stations are in remote areas. In case of alarm, the station calls a personal pager, displaying the individual code of the station. The radiation protection officer on duty can then contact the station with a portable PC and a modem and obtain a reading. The system is sensitive, but in practise it has been difficult to distinguish between real detection and temporary dose rate increase after heavy rainfall.

The new system is based on Genitron detectors (GT XL 2-3); each station has two large and one small GM-tubes and one heated rain intensity detector (dripping bucket). Data transmission is wireless via GPRS. There is no local data display. However the data can be read out locally via an IR connection with the help of a laptop if necessary.

6.2.3 Air sampling programme

The National Defence Research Establishment (FOI) operates a national air monitoring network of six stations to detect particulate radionuclides in the air. The filters are exchanged twice a week, but can be exchanged more frequently in an emergency on request of SSM. In the case of a large increase of radioactive particles, 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 fixed stations are supplemented by a set of mobile stations which can be transported quickly to regions where additional sampling capacity is needed. Three trucks with trailers are available for quick transportation of the mobile stations.

In addition to the FOI stations there are about 20 mobile air-filter stations of different kinds operated by the county administrations (counties where NPPs are located), the nuclear power stations, FOI and SSM. Sweden does not have dry/wet deposition collectors.

The ASS 500 air sampler in Stockholm is situated on the roof of the FOI building in a small cabin. The laboratory is also equipped with two types of portable air-samplers from Senya Ltd. The "Liliput" model has a flow volume of 7 m^3/h with an average duration of 4 hours of battery operation. With the other model, the Dwarf 100, air flow between 120 and 140 m^3/h can be achieved with low pressure drop filters. No actual maintenance or service is needed on these devices; the pump lasts for some 25.000 hours and it is the only moving part of these devices.

6.2.4 Water sampling programme

Surface water

Surface water is monitored in the sparse network, i.e. two stations representing the southern and the northern region of Sweden. 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.

Drinking water

Drinking water is also sampled at water plants, but in this case as the outgoing water. In addition to the water plants in Norsborg and Östersund, samples are taken at waterplants in Göteborg, Sandviken, Luleå and Kramfors. Ten to twenty litres of drinking water is collected by the water plant personnel twice a year (spring and autumn). The samples are analysed for Cs-137, Sr-90, H-3, total-α, total-β, U-234,238 and Ra-226. The analyses are conducted at the SSM and at the Studsvik facility.

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 Cs-137 and H-3, in addition a gamma radiation analysis using the same nuclide library as for measurements of discharge waters is performed on a one litre subsample.

Rain water

Rain water is collected at meteorological stations. Each collector is 2 m in diameter. Samples are collected each week, compiled and sent to FOI for analysis once a month.

6.2.5 Soil sampling programme

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

Cs-137 in agricultural soils is currently being mapped in Sweden. Top soils (0-20 cm) will be collected at approximately 1250 locations and analysed for Cs-137. At each location, 9 subsamples are taken within a 6 meter diameter circle of and then combined in a bulk sample. Crops at the same locations are also sampled (4 subsamples of 0.25 m^2 are combined into a bulk sample). This mapping project is 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.

6.2.6 Foodstuffs sampling programme

Milk

The sampling programme 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 is reporting according to the article 36 of the Euratom Treaty. Sampling is done at 5 dairies. In the year 2006 these dairies covered 65 % of the dairy milk production in Sweden and 78 % of the total intake of ^{137}Cs from milk consumption. The dairies are situated in Malmö, Jönköping, Kallhäll, Sundsvall and Umeå.

Sampling is done quarterly 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 the samples from the dairies are measured for Cs-137 and K-40. Samples from Kallhäll and Umeå are measured also for Sr-90. The reason for measuring only two dairies for Sr-90 is that the variation in the concentration in milk in different parts of Sweden is as significant for Sr-90 as it is for Cs-137.

Mixed diet

Mixed diet is collected in hospital canteens at three locations, 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. Gävle is sampled in accordance with the Commission recommendation on the application of article 36 of the Euratom Treaty to monitor foodstuffs which are affected by the Chernobyl fallout. Cs-137, Sr-90 and K-40 are measured.

Other foodstuffs sampling

Sampling of various foodstuffs as a means of assessing the exposure of the population as a whole in accordance with the article 36 of the Euratom Treaty is not presently done.

Samples of elk meat from two locations in central Sweden affected by the Chernobyl fall-out are measured each autumn for Cs-137. Other data on e.g. roe deer is sporadically sent in to the SSM from other institutions.

Sampling of mushrooms, fresh water fish and berries is done at a local level in the districts most heavily affected by the Chernobyl fall-out and reported by the local authorities to SSM at irregular intervals.

Reindeer meat is sampled and measured according to the decision of the district veterinary office at slaughter to safeguard against that meat exceeding 1500 Bq/kg Cs-137 should reach the retail system. This data is reported to the SSM.

6.2.7 Verifications

The verification team verified the following arrangements of the national environmental monitoring programme:

- Structure of the programme
- Operational unit of the old dose rate monitoring network at SSM
- Test unit of the new dose rate monitoring network at SSM
- Monitoring provisions at FOI in Stockholm
- Gamma dose rate monitoring stations situated at Gävle and Alunda
- ASS 500 air sampling station situated at the local purification plant in Gävle

Verification team noted that the Gavle gamma dose rate station was not running any more.

> *Verification does not give rise to recommendations. Verification team supports the dose rate monitoring network modernisation project.*

6.3 Municipality radiation measurement programme

6.3.1 Description

In Sweden there is a municipality radiation measurement programme, which requires each municipality (typically the municipality rescue service) to perform dose rate measurements every 7th month at selected locations (900 in total, 2-4 locations each) and report the results to the SSM database. SSM has provided each municipality with the necessary hand-held measurement equipment.

6.3.2 Verifications

Verification team verified the arrangements for the programme. Based on the verification the team noted the following:

- The programme is efficient, cost-effective and appears to meet the surveillance objectives. SSM's approach of involving the local municipalities in routine monitoring not only widens the national monitoring programme but also provides the local emergency services valuable experience in using their radiation monitoring equipment.

Verification does not give rise to recommendations.

6.4 SSM analytical laboratory

6.4.1 Description

The SSM analytical laboratory carries out measurements of the statutory discharge samples from the NPP's, environmental samples, national monitoring samples and foodstuffs samples. There is also a programme for mixed diet monitoring and special programmes for monitoring wild food (elk, moose and reindeer). Sample logs are kept on paper; there is no database system. This has been considered sufficient since the number of incoming samples is fairly low.

The laboratory counting room is classified as a low-activity laboratory. It is equipped with four HPGe detectors and two total alpha/beta counters (Quantulus). After measurements the samples are archived for ten years.

The laboratory is not accredited, but there is an ongoing project on creating a quality system. On a regular basis the laboratory participates in inter comparison exercises organised by the IAEA and the EC. In addition there are round-robin discharge measurement exercises among the Swedish and Finnish NPP's.

6.4.2 Verifications

Verification team verified the analytical arrangements at the SSM analytical laboratory in Stockholm. Based on the verifications the team noted the following:

- The laboratory is small, but adequately equipped. It appears that it is able to carry out its analytical tasks during routine conditions, but would fall short of analytical capacity should the number of samples increase.
- The laboratory has no accreditation (in fact there is no accredited radiation measurement laboratory in Sweden).
- There is no sample management database in the laboratory.

In addition:

- Some of the measurement instructions were handwritten and there appeared to be no systematic documentation for the measurement procedures.

The verification team recommends that the SSM analytical laboratory creates a formalised system of measurement and calibration instructions as a part of a comprehensive quality system and thereafter proceeds towards a formal quality accreditation.

The verification team suggests SSM to consider setting up a computer database for sample management at the laboratory. This is particularly important if the number of incoming samples should increase for any reason.

6.5 Mobile monitoring systems

6.5.1 SSM mobile monitoring vehicles

SSM has three radiation monitoring vehicles and three monitoring trailers. The equipment is kept distributed across the country with trained staff on stand-by. Each system is equipped with two NaI detectors and one HPGe detector. The HPGe detectors mounted on trailers can be removed and installed on police helicopters for airborne surveillance. In addition there are several hand-held instruments, environment sampling equipment and portable air samplers. Several SSM staff members have been trained to use the equipment in order to ensure 24h measurement capability during an emergency situation. In addition SSM maintains capability to carry out plume sampling using jet airplanes operated by the Swedish Air Force.

6.5.2 SGU airborne monitoring systems

The Geological Survey of Sweden (SGU) carries out airborne measurements of the radioactivity in the ground. The spectrometer used measures the gamma radiation that arises in the decay of different radioactive elements. Airborne measurements started in 1968 to map the uranium deposits in Sweden. Nowadays, the surveys are carried out along straight lines with a nominal separation of 200-800 m over land. Survey altitude is 60 m and point distance 16 m. About 80% of Sweden is covered.

In the monitoring aircraft NaI and HPGe (100% relative efficiency) detectors are suspended in a "cage" in order to avoid vibrations of the plane. The 16 litre NaI detector measures the energy interval between 0.2 and 3 MeV in 256 channels.

Calibration measurements are made over large calibration plates (12 m diameter) with known concentrations. There is one plate for each of the elements (K, U and Th) and one with almost no activity. Data over large lakes makes it possible to get calibration factors to compensate for the cosmic radiation, aircraft influence and electronic noise in the system. An upward looking 4 litre detector is used to compensate for radon in the air.

6.5.3 Verifications

Verification team verified the following components of the mobile monitoring systems:

- One of the SSM mobile monitoring vehicles in Stockholm
- Airborne measurement equipment at SGU in Uppsala

Verification does not give rise to recommendations.

7 CONCLUSIONS

All verifications that had been planned by the verification team were completed successfully. The team wishes to indicate its appreciation of the quality and the comprehensiveness of the information supplied to them before the visit.

A summary overview of the verification findings and related recommendations will be compiled in the 'Main Findings' document that is addressed to the Swedish competent authorities through the Swedish Permanent Representative to the European Union.

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

With respect to the radiological surveillance programmes related to the Forsmark NPP

(1) The verification activities demonstrated that the facilities necessary to carry out continuous monitoring of radioactive discharges from the Forsmark NPP are, in general, adequate. The Commission could verify the operation and efficiency of the facilities visited.

(2) The verification activities demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil around the Forsmark NPP are, in general, adequate. The Commission could verify the operation and efficiency of the facilities visited.

(3) However, in some areas the verification activities revealed room for improvement. These findings lead to recommendations that will be formulated in the Main Findings. These recommendations do not discredit the fact that the radiological surveillance of the Forsmark NPP is, in general, in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

With respect to the national radiological surveillance programmes

(4) The Commission could verify the operation and efficiency of the facilities visited.

(5) However, in some areas the verification activities revealed room for improvement. These findings lead to recommendations that will be formulated in the Main Findings. These recommendations do not discredit the fact that the radiological surveillance of the Swedish territory is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

With respect to the national radiological early warning network

(6) The verification activities demonstrated that the facilities necessary to carry out continuous monitoring of ambient gamma dose rates in Sweden are generally adequate. The Commission could verify the operation and efficiency of these facilities.

Final remarks:

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

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APPENDIX 1

RECEIVED DOCUMENTATION

Note: The list does not include various other documents that were asked for (and received) during the verification activities such as calibration certificates, standard operation procedures, quality assurance procedures, source records and measurement results, technical drawings, legislative texts, reports.

1. FILTRA MVSS Progress report No 5, ABB Atom, April 1987.
2. Strålsäkerhetsmyndighetens föreskrifter om arkivering vid kärntekniska anläggningar, Strålsäkerhetetsmyndighetens författningssamling, SSMFS 2008:38.
3. The Swedish Radiation Protection Authority's Regulations on the Protection of Human Health and the Environment from the release of Radioactive Substances from Certain Nuclear Facilities, Unofficial translation, December 15th, 2000.

APPENDIX 2

THE VERIFICATION PROGRAMME – SUMMARY OVERVIEW

EURATOM Article 35 Verification in Sweden

9 to 12 February 2009

PROGRAMME OF ACTIVITIES

Monday 9 February - Verifications in the Stockholm area

10:30 – 12:30 **Opening meeting at the Swedish Radiation Safety Authority (SSM)**

- Introductions
- Presentations
- Program of the verification visit

13:30 – 17:00 **Team 1: Verification of the environmental monitoring provisions at the SSM**

- Dose rate monitoring and other monitoring systems at SMM
- Automatic dose rate monitoring network data centre
- SSM radioanalytical laboratory
- Mobile monitoring systems

Team 2: Verification of the environmental monitoring provisions at the FOI

- High volume air sampler and other monitoring systems at FOI
- FOI radioanalytical laboratory

Tuesday 10 February - Verifications at the Forsmark NPP and surrounding area

09:30 – 10:30 **Opening meeting with the NPP personnel**

10:30 – 17:00 **Team 1: Discharge monitoring**

- Gaseous discharge monitoring systems at Forsmark 2

Team 2: Environmental monitoring

- Monitoring systems at the surrounding area (Gävle and Alunda)
- Airborne monitoring system (SGU Uppsala)

Wednesday 11 February - Verifications at the Forsmark NPP and surrounding area

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

- Liquid discharge monitoring systems at Forsmark 3

Team 2: Environmental monitoring

- Sampling arrangements
- Site meteorological systems
- TLD monitoring
- On-line dose rate measurements at the site area and vicinity
- Mobile monitoring systems

<u>Thursday 12 February - Verifications at the Forsmark NPP laboratories</u>

09:00 – 12:00 **Team 1: Discharge monitoring**
- Chemical and radiochemical laboratory at Forsmark 1
- Reporting arrangements and sample archive

Team 2: Environmental monitoring
- Operators laboratory for environmental samples
- Reporting arrangements and sample archive

13:00 – 13:30 **Closing meeting**
- Presentation of preliminary verification results

Datum 2008-01-09 SSM 2008/2773

Report on
Discharge and Environmental Monitoring

Forsmark NPP

and

National environmental radioactivity monitoring network

Sweden

Prepared in accordance with preparatory questionnaire for the Euratom Treaty Article 35 verification visit in February 2009

1. BODIES HAVING COMPETENCE IN THE FIELD OF ENVIRONMENTAL RADIOACTIVITY MONITORING

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 and the Swedish Nuclear Power Inspectorate 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 Activitites Act (SFS 1984:3). The Swedish parliament (*Riksdag*) 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 Radiation Protection Authority's Regulations on the Protection of Human Health and the Environment from the releases of Radioactive Substances from Certain Nuclear Facilities (*SSI FS 2000:12*) include provisions on environmental monitoring in the vicinity of nuclear facilities. The environmental monitoring programme is issued by the SSI (latest version, SSI report 2004:15, valid from 1st of January 2005) and specify type of sampling, sample treatment, radionuclides to be measured, reporting, etc. Every year a basic programme involving spring and autumn sampling is conducted. Furthermore, certain samples are taken on a monthly and quarterly basis. In addition to the basic programme, extended sampling is also conducted every fourth year at most of the facilities. The extended programme focuses exclusively on samples taken in the marine environment. The **National Board of Fisheries** conducts the sampling of environmental samples outside the facilities. The samples are analysed by the facilities themselves or at an external laboratory.

The **National Defence Research Establishment, FOI** operates a national air monitoring network to detect particulate radionuclides in the air.

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 NEA also includes radioactive contaminants.

Sweden is divided into counties (21) and municipalities (290). Food control at the local level is the responsibility of the relevant municipal committe(s), usually the Environment and Health Protection Committee. The County Administrations are responsible for co-ordinating food control within each county.

1.1. Participating laboratories

Laboratory	Adress	Contact person
SSM laboratory	Solna strandväg 96, 171 16 Stockholm	Lilián del Risco Norrlind/Lynn Hubbard
FOI, Stockholm	FOI, Totalförsvarets forskningsinstitut 164 90 Stockholm	Karina Lind/ Catarina Söderlund
FOI Umeå	Cementv. 20, 901 82 Umeå	Annika Tovedal, 090-106791
Studsvik AB	Nyköping	
Umeå Marina Forskningscetrum	Norrbyn, 910 20 Hörnefors	Anna Palmbo/Johan Wikner
Falma provtagning	Kryddstigen 14 E , 802 92 Gävle	Ulf Frykman, 026-101380
Lund	Lunds Universitet Medicinsk strålningsfysik Barngatan 3 221 85 Lund	Elis Holm, Christer Samuelsson
Riksmuséet	Box 50 007, 104 05 Stockholm	Anders Bignert
Swedish University of Agricultural Sciences	Department of Soil Sciences PO Box 7014, SE 75007 Uppsala (visit address: Ulls väg 17, Ultuna, 75651 Uppsala)	Klas Rosén, 018-671285
Sveriges geologiska undersökning, SGU	Box 670, 751 28 Uppsala	Ingemar Cato, 018-17 90 00

2. REPRESENTATIVES OF THE COMPETENT AUTHORITIES AND OTHER ORGANISATIONS INVOLVED IN ENVIRONMENTAL RADIOACTIVITY MONITORING

Name	**Position**	**Organisation/Authority**
Carl-Magnus Larsson	Head of Department of Radioactive Materials	**SSM**, Department of Radioactive Materials
Lynn Hubbard	Head of Section, Emergency Preparedness and Response	**SSM**, Department
Maria Lüning	Analyst, Environmental control	**SSM,** Department of Radiation Protection
Inger Östergren	Laboratory engineer	**SSM,** Department of Radiation Protection
Lena Wallberg	Laboratory engineer	**SSM,** Department of Radiation Protection
Jan Johansson	Analyst Emergency Preparedness and Response	**SSM,** Department of Radiation Protection
Christer Karlsson	Site Inspector, Forsmark	**SSM,** Department of Nuclear Power Plant Safety
Anki Hägg	Analyst, Discharges	**SSM**, Department of Radioactive Materials
Staffan Hennigor	Radiation Protection Manager	**Forsmark**, FQR- Safety and environment- Radiological safety
Erika Bohl Kullberg	Specialist in Radiology, PhD	**Forsmark**, FQR- Safety and environment- Radiological safety
Mattias Olsson	Radiochemistry Specialist, PhD	**Forsmark**, FTKS Chemistry specialists
Erik Kjellgren	Group Manager	**Forsmark,** FTK1 - Chemistry Surveillance unit 1 and 2
Charlotte Lager	Chemist	**Forsmark,** FTK1 - Chemistry Surveillance

		unit 1 and 2
Jan Ola Helmersson	Group Manager	**Forsmark,** FTK3 - Chemistry Surveillance unit 3
Maria Berglund	Chemist	**Forsmark,** FTK3 - Chemistry Surveillance unit 3
Anette Grundin	Chemist	**Forsmark**, FTK3 - Chemistry Surveillance unit 3
Felix Kuffner	Group Manager Radiophysics.	**Forsmark,** FTKR - Radiophysics
Tomas Larsson	Manager Waste Department unit 1	**Forsmark,** F1DR - Waste Department unit 1
Lena Eriksson	Engineer Waste Management	**Forsmark,** F1DR - Waste Department unit 1

3. LEGAL PROVISIONS FOR ENVIRONMENTAL RADIOACTIVITY MONITORING

The framework of concern in the field of environmental radioactivity monitoring is to be found in the Radiation Protection Act1 (SFS 1988:220), which aims to protect people, animals and the environment from the harmful effects of radiation and in the Environmental Code (SFS 1998:808), which addresses environmental aspects of nuclear activities and lists "nuclear activities " among several other "environmentally hazardous activities". The Swedish parliament (Riksdag) has appointed the SSM to implement its environmental quality objective Säker strålmiljö (A Safe Environment).

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 of concern 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 Council Directive 96/29Euratom of 13 may 1996.

3.1. Legislative acts regulating environmental radioactivity monitoring

- The Swedish Radiation Protection Authority's Regulations on the Protection of Human Health and the Environment from the releases of Radioactive Substances from Certain Nuclear Facilities (*SSI FS 2000:12)*.
- 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.*

3.2. Legislative acts regulating the 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

[1] All Swedish acts are published in the Swedish Statute Book, herein referrred to as "SFS"

3.3. Legislative acts regulating discharge monitoring

- The Swedish Radiation Protection Authority's Regulations on the Protection of Human Health and the Environment from the releases of Radioactive Substances from Certain Nuclear Facilities (*SSI FS 2000:12)*.

3.4. Guidance documents

- ICRP 60, ICRP 103;
- IAEA Safety Standard WS-G-2.3 Regulatory Control of Radioactive discharges to the environment
- EU BSS 96/29/EURATOM
- Council Directive 98/83/EC – Water directive
- EU Euratom article 35, 36 and 37.
- European Council directive 96/29/Euratom
- MARINA 2 Study, ERICA PROTECT
- HELCOM recommendation 26/3
- OSPAR Convention and the OSPAR strategy
    - OSPAR Decision 2000/1 on Substantial Reductions and Elimination of Discharges, Emissions and Losses of Radioactive Substances
    - Programme for the More Detailed Implementation of the OSPAR Strategy with regard to Radioactive Substances (ref. nr 2001-3)
    - OSPAR recommendation 2003/1 on the Strategy for the joint Assessement and Monitoring Programme
    - Agreement on monitoring programme for concentrations of Radioactive substances in the Marine Environment – ref nr 2005-8)
    - Agreed Reporting procedure for discharges from Non-nuclear sector
- 1991 UN/ECE Espoo Convention on Environmental Impact Assessment in a Transboundary Context

4. THE FORSMARK NPP SITE AND ITS RADIOLOGICAL SURVEILLANCE PROGRAMME

4.1. General description of the site and the reactors

Forsmark nuclear power plant is situated on the Swedish east coast about 4 km north of Forsmarks Bruk in Östhammar Municipality in Uppsala County. It is situated on the coastline of the Baltic Sea and uses sea water for cooling. The immediate surroundings with the villages Öregrund, Östhammar, Österbybruk, Gimo and Tierp are sparsely populated but the distance to large consumers of electricity such as the larger cities, Gävle, Uppsala and the whole Stockholm area is relatively short. The main recipient for water discharge is the Baltic sea. To study the effects of releasing the heated cooling water into the ocean an artificial "atoll", the Biotest lake, was constructed.

The plant consists of three nuclear power units, all of which are boiling water reactors (BWR). The power plant's industrial area also houses storage and workshop buildings necessary for the most common repair and maintenance work. In appendix 1 there is a map over Forsmark NPP.

The three nuclear power units, light water reactors of boiling water type, were all designed by former ASEA-ATOM (currently Westinghouse Electric). Construction of Forsmark 1 and 2 (F1, F2) started in 1971 and 1973 respectively and they were put into commercial operation in 1980 and 1981. They currently have a net output of 1010 MWe. The reactors produce saturated steam with a pressure of 7 MPa for direct use in the steam turbines (two turbine trains per reactor). The fuel in the reactor core is enriched uranium dioxide. The maximal thermal output in each unit is 2928 MW. Since the reactors have internal circulation pumps and fine motion control rods they are considered to be an early advanced boiling water design.

Forsmark 3 (F3) is similar to F1 and F2, although unit 3 has only one turbine train. Construction of the unit started in 1978 and it was put into commercial operation in 1985. Another difference between F1/ F2 and F3 is that the latter is designed to withstand seismic events far greater than those postulated to occur in Scandinavia. The physical separation is also more developed. F3 has 700 fuel assemblies (676 in F1 and F2), which generate a nominal output of 3300 MW. F3 currently has a net output of 1190 MWe.

Together, Forsmark reactors produce close to 25 TWh per year, which is about one sixth of the Swedish electricity production.

Forsmark Timeline
1971 Construction of F1 starts
1973 Construction of F2 starts
1978 Construction of F3 starts
1980 Referendum regarding nuclear power caused a delay of operation for the units
1980 F1 starts commercial operation
1981 F2 starts commercial operation
1985 F3 starts commercial operation
1986 F1&2 performs thermal power upgrade
1989 F3 performs thermal power upgrade
1989 The evaporator at F1 was taken into operation, (The F3 evaporator was in operation from start)

2004, 2005, 2006 Low pressure turbines are changed at F3, F1 and F2 respectively

All units at the Forsmark site are currently in commercial operation.

4.2. Regulation of discharges from nuclear installations

On the basis of the authorisation granted in the Radiation Protection Ordinance, SSM has issued 'Regulations on the Protection of Human Health and the Environment from the releases of Radioactive Substances from Certain Nuclear Facilities' [SSI FS 2000:12]. The regulations, which entered into force 1st January 2002, are

1 § …… applicable to the following nuclear facilities for which the Government has granted permission under section 5 of the Act (1984:3) on Nuclear Activities:
1. nuclear power reactor,
2. research or material testing reactor,
3. facility for fabrication of uranium pellets and nuclear fuel bundles,
4. facility for storage or other handling of spent nuclear fuel and
5. facility for storage, handling or final disposal of nuclear material or nuclear waste.

The regulations are applicable to all releases of radioactive substances from nuclear facilities that are directly related to the normal operation at each facility.

The regulations are not applicable
1. to shallow land burials of low-level nuclear waste under section 19 of the Ordinance (1984:14) on Nuclear Activities or
2. to the transport of nuclear material or nuclear waste outside the operational area of a facility or
3. to the dismantling of a nuclear facility or
4. after the closure of such a waste facility as that intended in the Swedish Radiation Protection Authority's Regulations (SSI FS 1998:1) on the Protection of Human Health and the Environment in connection with the Final Management of Spent Nuclear Fuel and Nuclear Waste.

4.2.1. The use of BAT

The regulations identify *Best Available Technique*, BAT as a means for limitation of releases as specified below:

4 § The limitation of releases of radioactive substances from nuclear facilities shall be based on the optimization of radiation protection and shall be achieved by using the best available technique. The optimization of radiation protection shall include all facilities located within the same geographically delimited area.
The possibility that radiation doses to the personnel can increase when releases to the environment are limited shall be taken into account during the optimization as shall the consequences of other waste management alternatives.

In the regulations, best available technique is defined as 'the most effective measure available to limit the release of radioactive substances and the harmful effects of the releases on human health and the environment, which does not entail unreasonable costs'.

BAT is applicable to all sources of radioactivity at a nuclear facility. In particular, nuclear power reactors are emphasised by the introduction of so called reference values and target values for the releases of radioactive substances.

6 § The reference values shall be established for each nuclear power reactor with respect to annual released activity of individual radioactive substances or groups of radioactive

substances. The reference values shall be worked out by the licensees and submitted to the Swedish Radiation Protection Authority for examination. The basis for the proposed reference values shall be attached to the notification.
Target values shall be established for each nuclear power reactor with respect to the release of individual radioactive substances or groups of radioactive substances and shall show the level to which the releases can be reduced over a specific period.

The reference value should show ‘the release level that is representative for optimum handling and full functioning of systems of importance to the origin and limitation of radioactive releases from a nuclear power reactor’. Decisive factors for defining reference values are operating experience and knowledge of the size of releases, in a historical perspective. Reference values can also comprise indicators of the efficiency of the effluent treatment systems. The reference values will be different for different reactors. It is important to point out that these values do not comprise limits or guidance levels, but can be considered to be a measure of the normal abatement capability. The values can consequently be changed, for example, when there is a change in release-limiting systems. Taking the BAT concept into consideration the facility shall also establish target values for each nuclear power reactor. The target value should show “the level to which the radioactive releases from nuclear power reactors can be reduced during a certain period of time”. The difference between reference values and target values is that reference values describe the current situation whereas target values indicate what can be achieved.

24 § No later than by January 31 each year, nuclear power reactor licensees shall report to the Swedish Radiation Protection Authority the measures that have been adopted or that are planned to be adopted to limit radioactive releases with the aim of achieving the target value specified in section 6. If reference values are exceeded, the measures that are planned to achieve the reference values shall be reported.

The licensees should yearly report which efforts have been taken in order to achieve the target value and explanations if the reference values have been exceeded.

4.2.2. Dose constraints/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 EU BSS, but the limit has been in use in Sweden since 1990, following the entering into force of SSM Regulations on dose limits in practices involving ionising radiation etc. [SSI FS 1989:1, revised SSI FS 1998:4].

According to the regulations [SSI FS 2000:12] 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 millisievert (mSv). The effective dose, which concerns the dose from external radiation and the committed effective dose from internal radiation, shall be integrated 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 in 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 within the most affected area for the period concerned.

4.2.3. Discharge limits

SSM has not defined any radionuclide specific discharge limits. Limitation of releases is being implemented through the restriction of dose to the critical group members. For each nuclear facility, e.g. each reactor at Forsmark, and for each radionuclide that may be released, specific release-to-dose factors have been calculated. The factors have been calculated for hypothetical critical groups, and take into consideration local dispersion conditions in air and in the environment, local settlements, locally produced food-stuffs as well as moderately conservative assumptions on diet and contribution of locally produced food-stuff 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 power reactors, release-to-dose factors (mSv/Bq) have been calculated for 97 radionuclides that may be discharged to the marine environment and 159 radionuclides that may be emitted to air. The dose contributions from all monitored radionuclides released are summed, and this sum shall not exceed 0.1 mSv for a calendar year.

4.2.4. Release Monitoring

The regulation stipulates the following concerning release monitoring:

12 § Releases of radioactive substances from a nuclear facility to the air and water shall be controlled through measurements. The detection limits of the measuring instruments shall be selected so that a comparison can be made with the values specified in section 5, and determined in accordance with section 6.

13 § Releases to the air via the main stacks of nuclear power reactors shall be controlled through continuous nuclide-specific measurements of volatile radioactive substances such as noble gases, through nuclide-specific measurements of continuously collected samples of iodine and particle-bound radioactive substances as well as through the measurement of carbon-14 and tritium.
Releases to the air from research and material testing reactors shall be controlled through nuclide-specific measurements of volatile radioactive substances such as noble gases and through nuclide-specific measurements of continuously collected samples of iodine and particle-bound radioactive substances.
Releases to the air from a facility for fabrication of uranium pellets and nuclear fuel bundles, for storage or other handling of spent nuclear fuel, and for storage, handling or final disposal of nuclear material or nuclear waste shall be controlled through nuclide-specific measurements of particle-bound radioactive substances in continuously collected samples and, where relevant, iodine and tritium.

14 § Releases to water shall be controlled through the measurement of representative samples for each release pathway. The analyses shall include nuclide-specific measurements of gamma and alpha-emitting radioactive substances as well as, where relevant, strontium-90 and tritium.

In principle, all released radionuclides should be monitored. In practice, however, there are a number of deviations. Since 2002, the emissions of C-14 and H-3 shall be monitored. Discharges shall be controlled through the measurement of representative samples for each release pathway. The analyses shall include nuclide-specific measurements of gamma and alpha-emitting radioactive substances as well as, where relevant, strontium-90 and tritium.

15 § Representative monthly samples of releases to the water from nuclear power, research and material testing reactors shall be submitted to the Swedish Radiation Protection Authority within two months after the end of the release month. Representative annual samples of releases to water from nuclear power, research or material *testing reactors shall be submitted to the Swedish Radiation Protection Authority within three months after the end of the release year.*

The SSM has granted the industry permission not to submit monthly samples of release water. Instead two water samples, one before and one after the yearly outage period should be sent to the authority. This is due to earlier evaluations that showed that this sample frequency is adequate.

The industry should have an implemented system for the control and maintenance of the measuring equipment and the release limiting systems and malfunctions of more importance 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.

16 § The function of measuring equipments and release-limiting systems shall be regularly controlled and also in the event of any suspicion of a malfunction. Written instructions shall exist for the maintenance of the equipment. Any modification of regular systems for the monitoring of releases shall be approved in advance by the Swedish Radiation Protection Authority.

17 § Measuring and sampling equipment for the control of releases to the air may be out of order for a period not exceeding 24 hours for maintenance or in the event of a malfunction without any special permission from the Swedish Radiation Protection Authority.
If the measuring equipment is out of order for a longer period of time, operation may continue, during non-office hours, until the Swedish Radiation Protection Authority has been contacted, on condition that the operation can be expected to be stable from the standpoint of releases. The reasons upon which this assessment was made shall be reported when the Swedish Radiation Protection Authority is contacted.
When the regular measuring equipment is out of order, other monitoring systems shall be used, to an adequate extent, in order to determine the released activity.
The measuring equipment may only be shut down, for other reasons, after special permission has been obtained from the Swedish Radiation Protection Authority.

Also, diffuse leakages of radioactive substances should be estimated and reported to the SSM.

19 § If the possibility of diffuse leakage of radioactive substances is suspected, and it is not possible to determine such leakage by measurements, an investigation shall be conducted to determine an upper boundary for possible undetectable leakage to air and water from the facility

4.2.5. Reporting

The licensees shall report nuclide specific releases to the SSM twice a year. An annual report shall contain also dose to representative person in the critical group, detection limits, measuring methods, estimates of diffuse releases in accordance with

Reporting
25 § The releases of radioactive substances to air and water, in accordance with sections 12 – 14, reported as released activity, and doses to individuals of the critical group, in accordance with section 5, shall be reported to the Swedish Radiation Protection Authority, in accordance with Appendix 1.

26 § If deviations have been made from sections 12 – 14, or when measurements have been conducted in accordance with section 17, third paragraph, the measurement system used during the period concerned in the report shall be specified as well as the way in which and how often the measurements have been conducted.

27 § Results from environmental monitoring shall be reported to the Swedish Radiation Protection Authority, in accordance with Appendix 2.

28 § Events leading to increased releases of radioactive substances from nuclear facilities shall be reported as soon as possible to the Swedish Radiation Protection Authority, describing the measures adopted to mitigate the releases.

4.3. Statutory discharge monitoring programme

The President of Forsmark Kraftgrupp AB, FKA, has the main responsibility for the fulfilment of the demands in laws and regulations. It is the responsibility of the operation management at each unit to ensure that the discharges of radioactive substances are consistent with the authorities' demands and Forsmark´s goals and policies. The partition of responsibilities between the operative organisation and the chemistry department is regulated in documentation.

Discharges of radioactive substances are only allowed at points where conversion factors between released activity and dose to a representative person are established. Table 1 and 2, summarise the discharge monitoring at the Forsmark NPP.

Table 1 Forsmark 1 och 2

Sample type	Sampling point	assignment	sampling	intervall	analysis	Other information
Aerial discharge	Main stack	553C11	Particles	Weekly	γ	Correction for sampling
Aerial discharge	Main stack	553C12	Iodine	Weekly	γ	
Aerial discharge	Main stack	553C9	H-3	1 p. 2 weeks	β	
Aerial discharge	Main stack	553C8	C-14	1 p. 2 weeks	β	
Aerial discharge	Main stack	553K905/6	Noble gases	On-line/6h	On-line γ	
Aerial discharge	Main stack	553C21	particles	1/month	α	Analysis of batch sample ev. 6 months
Aerial discharge	Main stack	553C21	particles	1/month	Sr-90	Analysis of batch sample ev. 6 months
Water discharge	Waste dep.	346R901	Particles	1/month	γ , H-3 (β) total α	Sampling per release, analysis of batch sample
Water discharge	Waste dep.	346R901	Acid stabilised sample	1/month	α	Analysis of batch sample ev. 6 months
Water discharge	Waste dep.	346R901	Acid stabilised sample	1/month	Sr-90	Analysis of batch sample ev. 6 months

Table 2. Forsmark 3

Sample type	Sampling point	assignment	sampling	intervall	analysis	Other information
Aerial discharge	Main stack	553CB11	Particles	Weekly	γ	Correction for sampling
Aerial discharge	Main stack	553BC12	Iodine	Weekly	γ	
Aerial discharge	Main stack	553CB6	H-3	1 p. 2 weeks	β	
Aerial discharge	Main stack	553CB5	C-14	1 p. 2 weeks	β	
Aerial discharge	Main stack	553KD742/1	Noble gases	On-line/6h	On-line γ	
Aerial discharge	Main stack	553CD21	particles	1/month	α	Analysis of batch sample ev. 6 months
Aerial discharge	Main stack	553CD21	particles	1/month	Sr-90	Analysis of batch sample ev. 6 months
Aerial discharge	Workshop	553CB71	Particles	1 p. 2 weeks	γ	Correction for sampling
Aerial discharge	Workshop	553BC72	Iodine	1 p. 2 weeks	γ	
Aerial discharge	Waste dep	553CC31	Particles	1 p. 2 weeks	γ	Correction for

						sampling
Aerial discharge	Waste dep.	553CC32	Iodine	1 p. 2 weeks	γ	
Water discharge	Waste dep.	346RX901	Particles	1/month	γ , H-3 (β) total α	Sampling per release, analysis of batch sample
Water discharge	Waste dep.	346RX901	Acid stabilised	1/month	α	Analysis of batch sample ev. 6 months
Water discharge	Waste dep.	346RX901	Acid stabilised sample	1/month	Sr-90	Analysis of batch sample ev. 6 months

4.3.1. Air discharge

Allowed release points for air are

- F1, main stack
- F2, main stack
- F3, main stack
- F3, ventilation stack for the hot workshop
- F3, ventilation stack for the waste handling facility
- F1, F2, F3, Emergency filter building stack.

The discharge from the exhaust stacks is controlled by on-line measurements of total radioactivity, nuclide-specific on-line monitoring of noble gases and continuous sampling of aerosol particles and iodine, with periodic filter change and measurements on removed filters.

From the main stack of each unit an iso-kinetic partial-flow is directed proportionally through five parallel sampling lines. For each sampling line calibrated gas flow meters are used to determine the passed volume.

<u>Sampling line 1 and 2</u>
The sampling lines are used for collection of aerosols and iodine using a combination filter with a glass-fibre filter attached to a carbon filter cartridge. The filters are changed and evaluated for gamma nuclides once a week (line 1) or once a month (line 2). The collected activity in the filters is continuously monitored by GM-detectors. If high values are measured, a third sampling line, line 3 starts automatically.

The samples are to be evaluated within 24 hours after filter removal. At evaluation the results are corrected for decay during the sample period. The filters are separated into the aerosol collecting part (glass fibre filter) and the iodine collecting part (carbon filter cartridge) before measurement on germanium detectors. The aerosol filters changed every month (line 2 or line 4) are also used for determination of Sr-90 and nuclide specific-α, measurements are done every 6 months on batch samples.

After having realised in 2006 that the values detected in line 1 of unit 1 were lower than they should be it was found out that the filter cartridge was not mounted correctly due to a malfunctioning rubber gasket. The maintenance routines have been changed after this and the rubber gasket is now changed every year.

To get a continuous measurement of the total gamma activity the air is led into measuring chambers with NaI(Tl) detectors after the aerosol and iodine filters. Cps-values from these detectors are continuously displayed in the control room. The detectors are continuously monitored using the attached check source. The computer system gives an alarm if the count values are too high or too low.

If the total activity measurement malfunctions, readouts from the nuclide specific measurement should be taken every hour or manual air samples should be taken every other hour for analysis in the laboratory.

If the sampling for iodine and aerosols is malfunctioning, manual air samples should be taken within 1 day.

Sampling line 3
This line is an extra line intended for future needs. It is supplied with particle- and iodine filters and can be used if the sampling in line 1 and 2 is malfunctioning.

Sampling line 4
In this line the discharge is continuously evaluated for noble gas content by nuclide specific gamma measurements using germanium detectors after having passed filters that remove aerosols and iodines that otherwise would have interfered with the measurements. The on-line gamma detector evaluates the data every 6 hours. There are two detectors, (553K905, 553K906 on F1 and F2 and 553KB741, 553 KD742 on F3) with separate electronics and computer systems. They are both running in parallel giving redundancy to the monitoring system. If the nuclide specific measurement is out of order (the total activity measurement is running) manual air samples should be taken once every 24 hours. This should be noted in the reports and the results should be calculated conservatively.

Sampling line 5
The flow in this line is led through sampling equipment that collects C-14 and H-3. C-14 is continuously collected in NaOH and H-3 is continuously collected in water. Every fortnight the samples are changed and after a couple of days (to allow for decay of short lived nuclides that otherwise could interfere with analysis) they are measured using a liquid scintillation detector. If the C-14 and H-3 sampling is not working, there should be a stand-in measurement system operating within 7 days.

The exhaust stacks by Forsmark 3's waste handling facility and hot workshop are surveilled by having a partial flow pass through filters that collect aerosols and iodine. The filters are changed and evaluated weekly as above, they are also monitored using NaI- detectors and an alarm will go off if the activity concentration in the filters becomes too high.

For emergency monitoring there are detectors in the main stack that are able to measure higher doses than the HPGe- and NaI-detectors. An ion-chamber and a Self Powered Gamma (SPG) - detector is connected to the control room for on-line continuous monitoring. To ensure that the detectors are working they are equipped with a background source. The systems will give an alarm when the signal is too low indicating that the systems might malfunction, or too high indicating an emission of radioactivity.

In case of an emergency pressure-release steam will be led through the emergency filter building and vented through the emergency filter building stack. The release from this stack is also monitored with an on-line ion chamber detector and aerosol and iodine filters. The filters are changed annually.

4.3.2. *Water discharge*

Water discharge is released to the cooling water outlet from two different locations:

- F1 release tank 00-342 T62/T64
- F3 release tank 30-342 TC61/TC62

At the waste treatment facilities at F1 and F3 radioactive waste water is collected in special tanks. The waste water is purified by an evaporator which gives almost pure water with most of the activity collected in a concentrate that is deposited in rock caverns of the underground repository, SFR-1.

The purified water is released to the cooling canals. Prior to release of water into the recipient a non-statutory pre-sample is taken and measured to control that the radioactivity is sufficiently low. This is done using a one litre sample flask on a 3” NaI-detector.

During the discharge a proportional part of released water is collected in a special tank. The water from this sampling tank is analysed each month with regards to nuclide specific gamma; samples are filtered through a glass fibre filter and the aerosol fraction (on the filter) and the water fraction are measured separately. Water is distilled before measurements of H-3 and 20 ml water is evaporated to measure total alpha. From each monthly sample a part is acidified by HNO_3 and kept to form a weighted 6 months batch sample which is used for evaporation to do nuclide specific alpha analysis and phase separation for Sr-90 analysis.
As an extra security measure on-line NaI-detectors measure the pipes during discharge. If the dose rate is too high the valves close and the water release stops. This measurement is connected to the central control rooms but the results are not used for statutory reporting.

Representative monthly samples, two for F1 waste facility and two for F3 are taken a month before the outage period and a month after the outage has ended. For F1 the first sample is prior to the first outage period of F1 or F2 and the second sample is after the last outage. The sample should be sent in to the Swedish Radiation Safety Authority, SSM, within two months after the monitored discharge month’s end.

Representative yearly samples of discharged water (for each release point) shall be sent in to SSM within three months after the end of the year.

4.4. Statutory site-related environmental radioactivity monitoring programme

4.4.1. *General*

The regulations [SSI FS 2000:12] include provisions on environmental monitoring. The environmental monitoring programme is issued by the SSM (latest version, SSI report 2004:15, valid from 1st of January 2005) and specifies type of sampling, sample treatment, radionuclides to be measured, reporting, etc. The site-specific monitoring programmes vary depending on the facility and are 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 basic programme involving spring and autumn sampling is conducted. Furthermore, certain samples are taken on a monthly and quarterly basis. In addition to the basic programme, extended sampling is also conducted every fourth year at most of the facilities. The extended programme focuses exclusively on samples taken in the marine environment. The National Board of Fisheries 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 programme, 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 control programme determines impact to the environment by monitoring dose rates and the concentration of radionuclides in water and on the ground. The programme also provides reassurance that discharges are estimated correctly and that unusual discharges to the environment are recognised early.

4.4.2. The environmental control programme at Forsmark

The main recipient for the discharge from Forsmark is The Baltic Sea, therefore the water environment is thoroughly monitored with samples from various water living organisms from a large number of sampling stations. There are in total 27 sampling stations within 13 km from the plant. 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 10 sampling stations for the land environment (excluding dosimeter stations), all within 12 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 to growth and reproducibility occur.
The environmental control programme consists of two parts: an annual base programme and an expanded programme performed every four years. The base programme makes it possible to detect short-term trends and covers a larger geographic area. The tables below summarises the content of the two programmes.

Table 3 Water environment, base programme

Sample type base programme	Number of stations	Frequency	Number of sample types	Number of samples / year
On growth samples	3	Monthly	1	36
Sediment	3	Quarterly/(autumn)	1	9
Algae	5	Autumn	1+2 replacements	5
Molluscs	4	Autumn	3	4
Fish	3	Spring/Autumn	4	9

Table 4 Water environment, expanded programme

Sample type base programme	Number of stations	Frequency	Number of sample types	Number of samples /fourth year
Algae	6	Each fourth year	3	10
Molluscs	8	-”-	3	9
Sediment	11	-”-	1	11

Table 5 Land environment

Sample type	Number of stations	Frequency	Number of sample types	Number of samples / year
Natural vegetation	7	Spring/ Autumn	5+2 replacements	17
Cultivated vegetation	3	July+ Autumn	5	7
Animal samples	1	Autumn	1	1
Milk	1	Each fortnight (pasture season)	1	10-14
sludge	4	Autumn	1	4
Dose rate measurements (TLD)	23	Quarterly		92

The location of the sample stations are given in appendix 2.

The Swedish board of fisheries delivers most of the samples but staff from Forsmark 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. Most samples are burnt into ashes in ovens and thereafter measured in established geometries on germanium detectors in the laboratory for environmental samples. The samples are analysed by gamma spectroscopy with regards to the following radionuclides: ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{58}Co, ^{60}Co, ^{65}Zn, ^{95}Nb, ^{110m}Ag, ^{113}Sn, ^{131}I (milk), ^{134}Cs, and ^{137}Cs

Detection limits for all nuclides are determined and reported to the SSM in the annual report.

Water sampling of the foundation drainage collection system is performed once a month. To verify that the drainage systems for each unit have not been contaminated, sludge samples are removed from pump holes every year after finished outage period. The sludge is measured by nuclide specific gamma analysis.

4.4.3. Dosimeters and dose rate measurements in the surroundings

For continuous evaluation of the gamma radiation in the vicinity, TL-dosimeters (LiF-700) are placed within a radius of about one km from the plant. These are changed and evaluated quarterly.

Six short link probes (from Genitron Instruments) are mounted in the surroundings and continuously monitor the dose rates (there is one mobile unit as well to be used in an emergency situation). The probes send data to the water tower where the signals are gathered and displayed in the Genitron software, accessible from computers at the plant. The system is intended for use in emergencies and not during normal operation. The location of the Genitron dose rate monitors are given in appendix 3.

To be able to warn the staff in emergency situations dose rate measurement monitors are installed in the main entrance, security centre and the switchboard room as well as in the control room of each unit. Mobile units are put up at nine assembly points in an emergency situation. The detectors are Automess Gamma-Alarm-Station 859.1 with a battery backup.

They are to be calibrated annually and their function is tested once every six months with a known source. Calibration and function testing is documented in a log-book.

4.4.4. Brief description of the meteorological sampling system

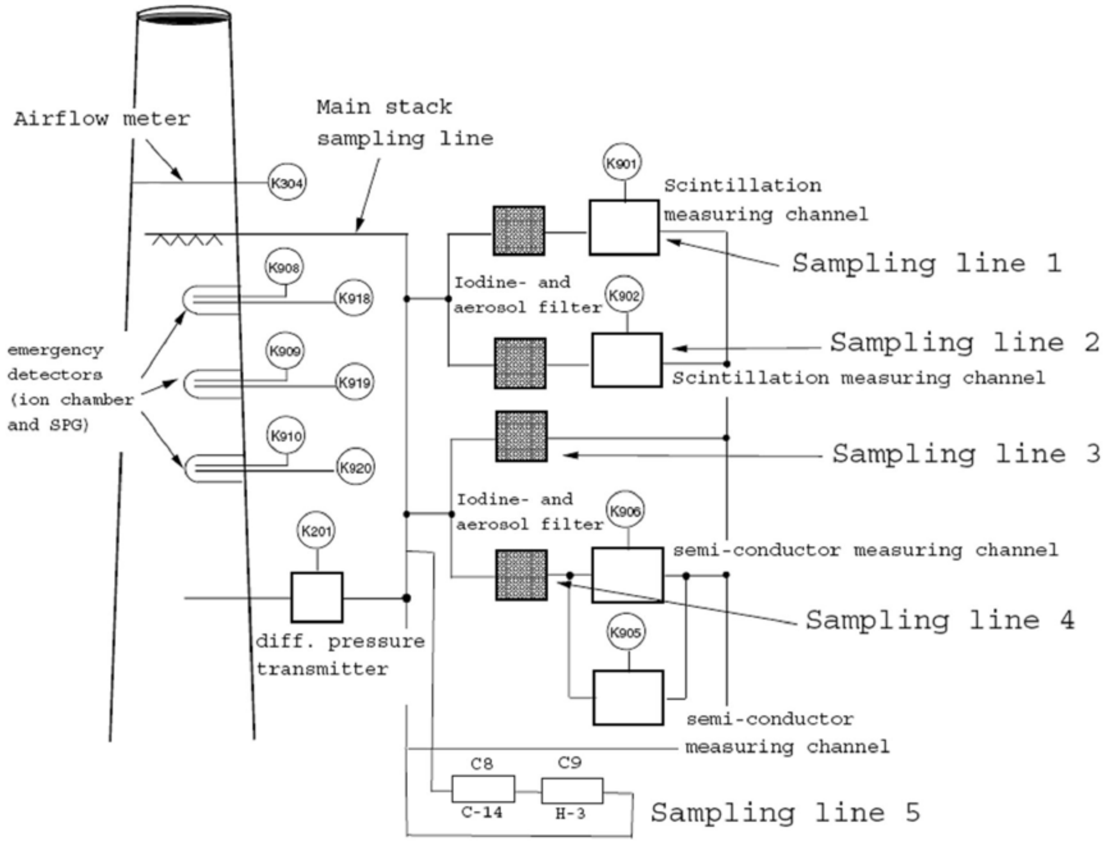
The meteorological station consists of a meteorology tower about 1 km from the plant. There are measuring points for temperature at 2, 8, 24 and 100m. The temperature difference between different heights is given for points above 2m. Windforce and direction are measured at 25, 50 and 100m. Measurement data is transferred to a server in the emergency centre where it is processed using the Airviro computer system (from SMHI, Sweden). Data can be reached through a web based application 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 cupper, this to give redundancy to the system.

5. FORMARK NPP ON-LINE LIQUID AND AERIAL DISCHARGE MONITORING

5.1. Aerial discharges

Sampling nozzles and a probe for the airflow meter is placed within the stack. All other equipment, such as filters, sampling sites, pumps, measuring chambers and detectors are placed in an adjacent room. The lead shielded measurement chambers for on-line HPGe measurements are placed on foundations in the room. The measurements are performed as activity concentration measurements. To determine the discharge rate the present airflow through the stack needs to be known. The airflow is given either by a summation of the flows into the stack from the ventilation systems or by reading flow meter 553 K3904 (F1/F2), 553 KB302 (F3).

553-aerial discharge monitoring system



5.1.1. *Nuclide specific Noble gas monitoring system*

The nuclide specific noble gas monitoring system has been replaced during 2008. On Forsmark 1 and 2 the on-line nuclide specific measurement system for noble gases is referred to as 553 K905 and 906. On Forsmark 3 the same detectors are referred to as 553 KB741 and KD742. The HPGe detectors and their electronic systems are of the brand Ortec, type GEM-15). They are coupled to computers running the software Windas (Gammadata, Uppsala, Sweden) which evaluates the data. On F1 and F2 the detectors have electric cooling systems (X-cooler 2, Ortec) while on F3 the detectors are cooled by liquid nitrogen.

The system continuously gathers 15 minutes gamma spectra that are integrated to 6 h spectra for evaluation and transfer of results to the plant-wide process database (PDB) system. The FURA Software is then used to generate dose reports based on data reported to the PDB.

On the control room panel the total cps measured can be displayed continuously as well as the cps of the check source, Cs-137, from the last 6 h period.

Both systems are identical and run in parallel, two detectors, two electronic systems and two computers to make sure that there is a redundancy in the system.

The air from the stack, comprising a representative sample of the total flow, is led into a measurement chamber with the detector inside. The chamber is shielded with lead rings. The check source, Cs-137, is lowered into the container. Aerosols and iodines are removed by filters prior to the detectors.

The chemistry department (FTK) makes check-ups of the system via Plant Vision, the interface of the PDB-system. Each month FTK controls that the measurement systems are active, that the spectra look as expected, and that the quality parameters are good. Annually a more detailed control takes place.
The detector's efficiency is calibrated using a verified air sample from the condenser off-gas system. Calibration is only done after major changes in the system or as needed.

The system runs with a check source, Cs-137, and various quality control parameters are controlled on the 662 keV Cs-137 peak. Cps-counts and energy calibration should be within a certain interval as well as the width of the peak. If the system malfunctions the control room is alerted. Their instruction says to contact the mechanical department for repairs and the chemistry department assess data integrity.

Since the systems are recently installed the annual limits of detections have not yet been determined. The detection limit values reported for last year (obtained with the old system) are shown in appendix 1.

5.1.2. Total gamma NaI-detectors

There are NaI(Tl)-detectors that measure total gamma in the main stack (553 K901 and 902 on F1/F2 and 553 KB711, KD721 on F3). The measurement systems are delivered by Studsvik Energiteknik, type 2220N with a 3x3" detector (5317G) and an EMI 9856 PM-tube. In sampling line 1 and 2 measurement chambers are situated after the aerosol and iodine filters. One of the NaI-detectors is placed at the chamber while the other is some distance away (15-30 cm). This to give a value that is as representative as possible. The chambers are lead shielded. The signal picked up by the PM-tube is treated in the pulse counter and a certain window is used, excluding irrelevant gamma. The detectors are equipped with a background source to ensure that the function is continuously monitored.

The signals from these detectors can be continuously displayed in the control room. Digital alarm signals are given to the signalling system if the pulse rates are too low (lower than normally given by the check source) or too high.

The alarm function of the NaI-gamma detectors are tested during operation by lowering calibration sources close to the NaI-crystals. This yields a high enough doserate to exceed the high-signal alarm limits. By breaking the connection between the amplifier and the rest of the electronics the low-signal limit is tested. That the corresponding signals are given in the control room is tested at the same time. By using other sources the energy and efficiency calibrations are tested. The range of the measurement window is 7 - 7x10^5 kBq/s for Xe-133 and 10 times higher for Kr-87.

The NaI-detectors in the main stack are not used for statutory discharge reporting.

5.1.3. Emergency detectors, main stack (553 K908-910, 918-920 on F1 and F2, 553 KD701-706 on F3)

In an emergency situation when the activity in the stack is too high for the NaI(Tl)- and HPGe-detectors to measure there are three additional separate and identical measurement systems. Each measurement system consists of two separate detector channels, one ion-chamber and one self powered gamma (SPG) with overlapping measurement windows. Combining both measurement windows provides the range 10^{-4}-10^6 Gy/h which should cover all possible cases. The measurement systems are fed from two separate battery secured power grids to ensure measurement function even with one power grid disconnected. The measurement systems are delivered from Studvik Energiteknik AB. The ion chambers are of type RS-C4-1606 from Reuter Stokes and the SPGs are type 5507A.

The channels continuously monitor the activity level in the stack. During normal conditions no signal above the background source is detected. There will be an alarm if the cps-count is lower than the one given by the background source, or if the activity level goes above a pre-set level. The activity level is continually registered on a printer in the control room.

The function of the ion chambers is tested using calibration sources. By connecting a test unit to the pre-amplifier different data can be simulated and the function of the alarm limits and local and central display units can be tested. The SPG-detectors are tested in the same way but no calibration sources can be used since the measurement window is so high.

5.1.4. Detectors in emergency filter building stack.

In the emergency filter building stack there are ion-chambers (from Technical Associates type F1L-5F1R-5) that continuously monitor the activity concentration (553 K931, K932 for F1, F2 and 553 KA791, KB791 for F3). The detectors are placed directly against the measurement chamber without collimators to obtain a representative measurement. The detectors are lead shielded to keep the background low. The results are monitored locally and in the control room and can be reached through local monitoring positions. Alarm for high values and low values (below background source) can be seen in local monitoring positions and the central control room. The ion-chamber measurement channels are tested using calibration sources (Cs-137). Limits and links to local and central display systems are controlled.

5.1.5. Filter pack monitors

Filterpacks in sampling line 1 and 2: To surveil the filterpacks a GM-tube detector is used. The system is delivered by Studsvik Energiteknik model 2001c with a GM-tube from Philips. If the activity levels are too high an alarm is given and the airflow will be directed through line 3 instead. Testing and calibration is done as for ion-chambers above.

Hot workshop and waste treatment facility on F3: The filters are monitored by NaI-detectors, placed adjacent to the filter. The filters and the detectors are surrounded by a lead shield. The signal from the detector is processed in a multi- channel analyzer with built-in rate meter. The detector has a background source, which makes it possible to monitor that the detector system works as planned. If the activity levels are too high (or too low) there will be an alarm in the central control room.

The detector is calibrated to give information on the activity concentration in the filter. This is done using a specified amount of Cs-137 or Co-60 in the filter.

The alarm levels of the gamma-detectors are tested during operation through recurring testing. Radioactive sources are inserted to the crystals making the detector signal so high that the alarm limits are passed. By breaking the connection between the detector and the analyzer no signal from the background source is given and the low signal limit is tested. At the same time it is tested that alarm signals are given in the control room (for the waste facility, the local control room). That the instruments locally and in the control room agree is tested with attached sources. Energy and efficiency calibration is tested regularly as well.

5.2. Water discharge

At F1 and F3 the release of water to the cooling water canal is monitored using on-line NaI(Tl)-detectors, (Studsvik Atomenergi, type 1311D), designated, on F1 00346 K901/902 on F3 30554 KD770. The detectors, serving no statutory needs, serve as an extra precaution monitoring the discharge. If the activity reaches a certain value the valves will close, stopping the release of water. The data is reported to the central control rooms. The function of the detectors is monitored using a background source of Cs-137. For calibration a calibration source (Co-60) is lowered through the lead shield, and together with the background source an energy and efficiency calibration is made. Control of the system is done monthly.

6. LABORATORIES PARTICIPATING IN THE (DISCHARGES AND ENVIRONMENTAL) SURVEILLANCE OF THE FORSMARK NPP SITE

At Forsmark 1 and Forsmark 3 there are chemical and radiochemical laboratories in the radiologically controlled area (RCA). The Forsmark 1 laboratory also serves the Forsmark 2 site. Chemical and radiochemical analyses from several different systems are analysed in these laboratories. The radiochemical laboratories have separate rooms for sample preparation and measurement of radioactivity.

6.1. Chemical and radiochemical laboratory at Forsmark 1 (also serving Forsmark 2)

6.1.1. Sample reception: Sample identification and registration procedures

When the samples are taken to the laboratory they are registered in the laboratory database WilabLIMS. The unit, sample point and date and time for start and stop are noted and the sample gets a serial number. WilabLIMS is also equipped with a sampling schedule and asks for samples automatically.

6.1.2. Sample preparation and measurements

Aerial discharges
Aerosols/particles and iodine are measured in one cartridge with two filters.
The glass fibre filter where aerosols and particles are caught is removed from the filter cartridge using a knife. To check that the flow through the filter has been normal the colouring of the filter is noted and shall be in the bottom half of an 8 grade scale (but still visibly coloured) for one week samples. The filter is put in a small cerbo-dish with unit, system and time for start and stop clearly written on the lid. The filter is then measured on an HPGe-detector for half an hour. Filters from the main stack are measured within 24 hours. Nuclides assessed are aerosol corrosion products (Co-60, Co-58, Cr-51, Mn-54 etc.) and if existing, fission products such as Cs-isotopes.

Calculations to Bq/s is done in via the gamma measurement system (VAX/VMS), the results obtained in Bq/m^3 is multiplied with the airflow (given in m^3/s). A mean of the airflow through the filter during the period is calculated from values gathered through the Plant Vision system or read out in the central control room.

The sampling efficiency of the particle filters is estimated to be 36% and a correction factor is set in the gamma measurement system which multiplies the particle results by a factor 2.78.

Iodines
The carbon filter part of the cartridge is after removal of the glass fibre filter placed in a plastic bag and measured for iodines. It is measured for half an hour on an HPGe detector within 24 h after sample change. For iodines a 100% sampling efficiency is assumed. No correction factor is therefore given. The results are converted to Bq/s in the gamma measurement system as above.

H-3 & C-14
Air from the stack is led through 4 flasks for each nuclide. For C-14 the air is bubbled through 2 M NaOH in glass flasks and H-3 is collected in water in plastic flasks. The samples are collected every fortnight. Between flask 2 and 3 there is a catalyzing system that oxidizes CH_4 and H_2 to CO_2 and H_2O respectively that can be captured in the bubble flasks.

C-14

Double samples are prepared with 3 ml sample from the glass flasks and 17 ml liquid scintillation cocktail (Optiphase Hisafe 3). Blanks are prepared fresh as well. Samples are analysed after 1 day for 20 minutes on a Perkin Elmer, Tri-Carb 2900 liquid scintillation counter. The delay is to allow sample luminescence to dissipate.

H-3

Double samples with 10 ml sample from the plastic flasks and 10 ml liquid scintillation cocktail are prepared (Ultima Gold XR). Blanks are prepared fresh as well. The samples are measured after at least 2 h for 15 minutes on a Perkin Elmer, Tri-Carb 2900 liquid scintillation counter.

Calculations are done in Excel, a new sheet for each analysis.

Sr-90

To determine the Sr-90 content of the air samples, the sample is prepared as follows: 6 monthly aerosol filters are gathered (the analysis is done every 6 months). The nuclides on the glass fibre filters are extracted using H_2SO_4 (Aq), evaporated and dissolved in HNO_3. HDEHP in an organic solvent is then added and after extraction and separation, the lower water phase is collected. After 3 weeks the sample is extracted again using HDEHP and the organic phase is kept. It is essential that no water phase remains. The sample is transferred to a glass scintillation vial and analysed at once in a liquid scintillation counter. The samples are measured repeatedly during the following weeks. The results are evaluated using a macro in Microsoft Excel with manual curve fit and readout of the cpm of Y-90. The Bq/m^3 value can then be calculated and converted to Bq/s by multiplying by the mean airflow through the filters. The Efficiency of the analysis is determined by known standards that are prepared together with the other samples.

Alpha

6 monthly filters from the sample point are gathered and trace-labelled using 0.1-0.15 Bq U-233. After the filters have dried (not longer than one week) the nuclides are leached using H_2SO_4. The sample is evaporated until only a few ml remains and after some further preparation, 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.

Water discharges

Particles

A proportional monthly sample is filtered through glass fibre filters by staff at the waste department. Chemistry department staff picks up filters and filtrate.

From the bottle with filtrate one litre is taken for gamma specific measurements. One aliquot is removed for analysis of H-3 and total alpha and the rest of the water is kept for six month- and annual samples.

The filters are placed in a cerbo-dish. One litre of the filtrate is transferred to a Marinelli-beaker. The water samples are measured on an HPGe-detector for 50000 s.

H-3
200 ml of the one month batch sample is distilled and 10 ml distilled water is mixed with 10 ml liquid scintillation fluid (Ultima Gold XR). Blanks are prepared fresh as well. The samples are analysed after at least 2 h on a Perkin Elmer, Tri-Carb 2900 liquid scintillation counter.

Sr-90
3 litres of water sample (6 months batch sample) is evaporated and when the sample is dry the remains are dissolved in HNO_3. HDEHP in an organic solvent is then added and after separation, the lower water phase is collected. After 3 weeks the sample is separated again using HDEHP and the organic phase is kept. It is essential that no water phase remains. The sample is transferred to a glass scintillation vial and analysed at once in a liquid scintillation counter. The samples are measured repeatedly during the following weeks. The results are evaluated using a macro in Microsoft Excel with manual curve fit and readout of the cpm value, from which the Bq/m^3 value can be calculated.

Alpha
Total alpha: 20 ml water is evaporated onto a plate and measured in a total-alpha counter for 50000 s.
Nuclide specific alpha: 50 ml water from the 6 months batch container is mixed with 0,03-0,1Bq U-233 tracer. The sample is evaporated until only a few ml remains and after some further preparation, 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.

6.1.3. Measurement devices in the lab

In the lab of Forsmark 1 the nuclide specific gamma measurements are performed using 3 multi channel analyzing systems with HPGe detectors from Canberra and electronics from Canberra (DSA 2000) and different NIM manufacturers. For evaluation an Alpha/VMS-system with the software Pro-count, and Genie is used. The Genie software calculates the results to Bq/m3 and to obtain release rate, Bq/s, further calculations are done in the VMS system. The results are stored in the WilabLIMS database and manually transferred to the PDB-system for calculations of dose data using FURA. The detectors have a relative efficiency of 10-20 % and their stability is tested every fortnight. The detector systems are controlled using a check source consisting of Am-241, Cs-137 and Co-60. Background checks to monitor detector contamination, or radioactive materials near the detectors, are also done every other week. QA and background measurements are stored in the lab LIMS database.

The lab also has a Perkin-Elmer liquid scintillation analyzer, Tri-Carb 2900. The built in software calculates the results to Bq/m^3. Manual calculations, (using Microsoft Excel) is needed to obtain Bq/s. Instrument performance assessment is done automatically everyday. The results are stored internally, and trends are monitored. Three standard samples are used for the assessment: backround sample, H-3 sample and C-14 sample.

To measure total alpha, the lab has an old dark chamber with a ZnS-layer which scintillates upon alpha-hits. The scintillation flashes are then picked up by a PM-tube. This detector is not used for statutory monitoring. A stability analysis is done with an Am-241 source. Background is measured using a cleaned plate.

To measure nuclide specific alpha there is an old instrument (to be replaced shortly) that consists of three vacuum chambers with Canberra/Tennelec-detectors. The detectors are connected to Canberra electronics and VMS computers with Pro-Count Genie-software. The system is not calibrated since it relates the output to the trace labelled U-233 included in each sample. This because it is difficult to do a reliable calibration since the quality of the electro-deposed layer on the plate can vary.

6.1.4. Measurement results

Results, (final results plus raw data) of measurements on aerial and water discharge and environmental surveillance are archived for long term storage. Discharge reports, reports on the fulfilment of reference and goal values as well as environmental surveillance reports are stored long term in the central archive. There is no comprehensive policy regarding how to deal with results below detection limits. For some analyses the detection limit value is reported and for some the value of non-detected nuclides is set to 0. What is applicable is given by the instructions.

6.1.5. Data handling and reporting tools

All results of the discharge monitoring are stored in WilabLIMS-database. The data is then transferred "manually" to the PDB-system .

6.1.6. Statutory accounting and reporting obligations with respect to discharge sample results

The department for safety and environment, FQ, sends six-month and annual reports to SSM.

In addition to the written reports, one annual water sample and two unfiltered monthly samples, acidified with HNO_3, shall be sent to SSM. Normally the monthly samples are for the months prior to and after the yearly outage.

6.1.7. Sample storage and archiving requirements

Water samples from each release point are kept for 10 years. The samples, stabilized with HNO_3, are weighted yearly samples of at least 5 litres. Monthly water samples from each release point are kept for two years. Aerosol filters are stored for at least 10 years and the active carbon filters for iodine capture are kept for at least 3 months.

6.1.8. Quality assurance and control procedures

Stability tests are performed on the HPGe-detectors at least every fortnight to assure that the efficiency of the detectors is not changed and that resolution is not degraded. The results are documented with continuous follow-up. The stability of the liquid scintillation detector is controlled automatically. On the total-α-counter the stability test is performed at least once a month. If the stability tests limits falls beyond 3σ, the cause shall be found and fixed.

Background checks are done on HPGe-detectors, liquid scintillation counters and total alpha counters at least once a month to find background variations and contamination. If the background is significantly raised the detector is cleaned (HPGe only) and the background check redone.

The results of performed instrument calibrations are documented and kept in a binder "Detektorkontroller". Background checks and stability tests are also registered in WilabLIMS. For the liquid scintillation counter the values are stored in the instrument computer. Results are plotted regularly and put in a binder.

Subsequent checkups are documented and kept for at least one year after the end of the calendar year where the calibration result last have been used.

6.1.9. Laboratory accreditations

The chemistry department participates in four different inter-laboratory comparisons. The aim of the comparisons is to check and verify the validity of measurements of active and inactive samples as well as dosimeters. A comparison of the measurements of radioactive liquids by HPGe, liquid scintillation counters, Gamma spectroscopy, total alpha and Sr-90 is arranged annually by the Nordic Radioactive Laboratory Conference.

6.2. Chemical and radiochemical laboratory at Forsmark 3

6.2.1. Sample reception: Sample identification and registration procedures

When the samples are taken to the laboratory they are registered in the laboratory database WilabLIMS. The unit, sample point and date and time for start and stop are noted and the sample gets a serial number.

6.2.2. Sample preparation and measurements

Aerial discharge

Aerosols/particles

Aerosols/particles and iodine are measured in one cartridge with two filters.
The glass fibre filter where aerosols and particles are caught is removed from the filter cartridge using a knife. To check that the flow through the filter has been normal the colouring of the filter is noted and shall be in the bottom half of an 8-grade scale (but still visibly coloured) for 1 week samples. The filter is put in a small cerbo-dish with unit, system, time for start and stop clearly written on the lid. The filter is then measured on a HPGe-detector for 1800 s. Filters from the main stack are measured within 24 hours, filters from other locations, within 36 h after filter change. Nuclides assessed are aerosol activated corrosion products (Co-60, Co-58, Cr-51, Mn-54 etc.) and if existing, fission products such as Cs-isotopes.

Calculations to release rate (Bq/s) is done via the gamma measurement system (VAX/VMS), the results obtained in Bq/m^3 are multiplied with the airflow (given in m^3/s). A mean of the airflow through the stack during the period is calculated from values gathered through the Plant Vision system, obtained through measuring point 553KB302 read out in the central control room.

The sampling efficiency of the particle filters is estimated to be 36%. A correction factor is set in the gamma measurement system which multiplies the particle results by a factor 2.78.

Iodine
The carbon filter part of the cartridge is placed in a plastic bag and measured for iodines after removal of the glass fibre filter. It is measured for 1800 s on a HPGe-detector within 24 h of sample change. For iodines a 100% sampling efficiency is assumed. No correction factor is therefore given. The results are converted to release rate (Bq/s) in the gamma measurement system as above.

H-3& C-14
Air from the main stack is led through a sampling system with 4 flasks for each nuclide. For C-14 the air is bubbled through 2M NaOH in glass flasks and H-3 is collected in water in plastic flasks. The samples are changed every fortnight.

C-14
Double samples are prepared with 3 ml sample from the glass flasks and 17 ml liquid scintillation fluid (Optiphase Hisafe 3). Blanks are prepared fresh as well. Samples are analysed for 20 minutes on a Perkin Elmer liquid Tri-Carb 2900 scintillation counter, after 1 day to allow for any chemoluminescence to cease.

H-3
Double samples with 10 ml sample from the plastic flasks and 10 ml Ultima Gold XR liquid scintillation fluid. Blanks are prepared fresh as well. The samples are counted for 15 minutes on a Perkin Elmer Tri-Carb 2900 liquid scintillation counter, after at least 2h.

Calculations are made in Excel, a new file for each analysis, and the values are collected automatically from the scintillation counter. It is therefore important that the samples are in the correct order with the right number of blanks.

Water discharge

Particles
Each month a proportional batch sample of released water is prepared of which 3 Litres of water is separated through a glass fibre filter. The filter is placed in a cerbo-dish. One litre of the filtrate is transferred to a Marinelli-beaker. The water samples are then measured on an HPGe-detector for 50000 s

H-3
200 ml of the 1 month batch sample is distilled and 10 ml distilled water is mixed with 10 ml Ultima Gold XR liquid scintillation fluid. Blanks are prepared fresh as well. The samples are analysed after at least 2 h on a Perkin Elmer Tri-Carb 2900liquid scintillation counter.

Alpha
Total alpha: 20 ml water is evaporated onto a plate and measured in a total-alpha counter for 50000 s.

6.2.3. Measurement devices in the laboratory

In the lab of Forsmark 3 the nuclide specific gamma measurements are done using a Canberra DSA 2000 multichannel analyzing system with 2 HPGe-detectors, one Intertechnique and one PGT. For evaluation a VMS-system with Pro-count and Genie is used. The Genie software calculates the results to Bq/m^3 and the results are stored in the WilabLIMS database. To obtain release rate, Bq/s, further calculations are done in the VMS system. The detectors have a relative efficiency of 10-20 % and their stability is tested every fortnight. The detector systems are controlled using a check source consisting of Am-241, Cs-137 and Co-60. Background checks to monitor detector contamination, or radioactive materials near the detectors, are also done every other week

The lab also has a Perkin-Elmer Tri-Carb 2900 liquid scintillation analyzer,. The built in software calculates the results to Bq/m^3. Manual calculations, (using Microsoft Excel) are needed to obtain Bq/s. The instrument performance assessment is done with three standard samples daily. Several quality parameters are examined.

To measure total alpha, the lab has a dark chamber with a ZnS-coated PM-tube which scintillates upon alpha hits. The scintillation flashes are then picked up by the PM-tube. This detector is not used for statutory monitoring. A stability analysis is done with an Am-241 source. Background is measured using a cleaned plate.

6.2.4. Measurement results

Results, (final results plus raw data) of measurements on aerial and water discharge and environmental surveillance shall be archived for long term storage. Discharge reports, reports on the fulfilment of reference and goal values as well as environmental surveillance reports are stored long term in the central archive. There is not a comprehensive policy regarding how to deal with results below detection limits. For some analyses the detection limit value is reported and for some the value of non-detected nuclides is set to 0. What is applicable is given by the instructions.

6.2.5. Data handling and reporting tools

All results of the discharge monitoring are stored in a WilabLIMS database. The data is then transferred manually to the PDB-system

6.2.6. Statutory accounting and reporting obligations with respect to discharge sample results.

The department for safety and environment, FQ, sends reports to SSM annually and each six months.

In addition to the written reports, one annual water sample and two unfiltered monthly samples, acidified with HNO_3, shall be sent to SSM. Normally the monthly samples are for the months prior to and after the yearly outage.

6.2.7. Sample storage and archiving requirements

Water samples from each release point are kept for 10 years. The samples, stabilized with HNO_3, are weighted yearly samples of at least 5 litres. Monthly water samples from each release point are kept for two years. Aerosol filters are stored for at least 10 years and the active carbon filters for iodine capture are kept for at least 3 months.

6.2.8. Quality assurance and control procedures

Stability tests are performed on the HPGe-detectors at least every fortnight to assure that the efficiency of the detectors is not changed and that the resolution has not degraded. The results are documented with continuous follow up. The stability of the liquid scintillation detector is controlled automatically. On the total-α–counter the stability test is performed at least once a month. If the stability tests limits falls beyond 3σ, the cause shall be found and fixed.

Background checks are done on HPGe-detectors, liquid scintillation counters and total alpha counters at least once a month to find background variations and contamination. If the background is significantly raised the detector is cleaned (HPGe only) and the background check redone.

The results of performed instrument calibrations are documented and kept in a binder “Detektorkontroller”. Background checks and stability tests are also registered in Excel. For the liquid scintillation counter the values stored in the instrument computer. Results are plotted regularly and put in a binder.

6.2.9. Laboratory accreditations

The lab participates in comparative testing between Nordic power plants and in one international network. The aim of the comparisons is to check and verify the validity of measurements of active and inactive samples as well as dosimeters. A comparison of the measurements of radioactive liquids by HPGe, liquid scintillation counters, Gamma spectroscopy, total alpha and Sr-90 is arranged annually by the Nordic Radioactive Laboratory Conference.

6.3. The operator’s laboratory for environmental samples

The laboratory for environmental samples and whole body measurements is located at Forsmark 2. The laboratory is not in the controlled area. It has separate rooms for sample preparation and measurements of radioactivity.

6.3.1. Sample reception: Sample identification and registration procedures

Samples are recorded in a binder when they are delivered. When treatment of each sample starts it is labelled with a serial number and a protocol is filled in for each sample. After measurement each sample is registered in a database.

6.3.2. Sample preparation

The samples are dried and all samples, except on-growth samples are burnt into ashes.

6.3.3. Sample measurements

Samples are measured for 80000 s on an HPGe-detector. The nuclide library is set and is attached in appendix 2.

6.3.4. Measurement devices in the laboratory

The lab has 2 HPGe-detectors, one Canberra and one Enertec. For service and maintenance there is an agreement with Canberra in Uppsala. Calibration of the equipment is performed with self made preps. Calculations of the results are performed in Genie ESP-software.

6.3.5. Measurement results

Raw values on paper are stored in an interim archive approximately 18 months they are then transferred to the central archive. Detection limits are given in the reports for 12 specified nuclides; all other detection limits are on the print-out of the measurement results.

6.3.6. Data handling and reporting tools

Data from the measurements are registered in a local database.

6.3.7. Statutory accounting and reporting obligations

Reporting to SSM is given in half year and annual reports with set parameters. The safety and environment department, FQ, is responsible for sending the reports to SSM.

6.3.8. Sample storage and archiving requirements

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

6.3.9. Quality assurance and control procedures

Control of the detectors is done every week, calibration and control of the scales is done every year. Double samples are taken for control measurements at other laboratories. External reviews (WANO, OSART, SSM) as well as internal audits take place regularly.

6.3.10. Laboratory accreditations

The lab is not accredited but they take part in the inter-calibration campaigns that they obtain knowledge about and that are relevant for the line of work.

6.3.11. Outsorced

Sampling is done by staff from the board of fisheries' coastal laboratory in Öregrund. This is formalized in an agreement with SSM since it is important that an independent agency does the sampling.

6.4. The regulator's laboratory for discharge samples and for site-related environmental samples

SSM has a laboratory for alpha, beta and gamma spectrometric measurements on plan 2 of SSM's office building at Solna strandväg 96 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 contained whole body counting room.

6.4.1. Sample reception: sample identification and registration procedures

The samples arrive at the SSM with sample code, 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 doubly in the laboratory: electronically to the counting/analysis systems and by paper records.

6.4.2. Sample preparation: methodologies used to prepare samples before measurement

There are two sample preparation rooms that have separate areas and equipment for low activity versus higher activity samples. Samples are received from the environmental monitoring program, the specific NPP discharge and site-related environmental samples, samples from different supervision activities and samples from different inter-calibration programs. In the event of an emergency, a different 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 measurement: Samples are either fresh or dried in the 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), or impregnated $Cu_2(Fe(CN)_6)$ filters.
- 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 610º C. The ash is dissolved in 1M 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 3M HNO_3 and precipitated as hydroxide. The hydroxide precipitation is dissolved in 1ml conc. HNO_3 plus 10 ml H_2O destilled water then transferred to a liquid scintillation vial and the Cerenkov radiation from Y-90 is counted in a LSC counter Quantulus1220.
- H-3: 15 ml of the sample is treated with a mixture of anion and cation exchanger 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 cocktail Ultima Gold LLT. With every measurement a blank sample and a tritium standard sample are also measured. The sample is counted in a LSC counter Quantulus1220.
- 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 1220.

6.4.3. Sample measurements

Radioactive releases to water (discharges) are controlled through the measurement of representative samples for the release pathway. The surrounding environment is controlled through measurements of representative terrestrial and marine samples.
In both cases the analyses cover nuclide-specific measurements of the concentration of gamma radioactive substances and in some cases the concentration of H-3 in water samples. The samples received as part of the control program of NPP and the measurements performed are stated below:

Discharge samples:

Water discharges before and after outage period	Gamma measurement with NPP library
Pooled 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

* Some of these samples are outsourced to a third party for analytical assessment. Please see section 6.4.10.

The national environmental monitoring program

The samples received as part of the national environmental monitoring program and the measurements performed are stated below:

Surface water	Cs-137, total-alpha, total-beta, Ra-226
Drinking water	Cs-137, Sr-90, H-3, total-alpha, total-beta, Ra-226
Consumption milk	Gamma measurement, Cs-137, Sr-90, K-40
Mixed diet*	Gamma measurement, Cs-137, Sr-90
Marine samples*	Gamma measurement with NPP library
Whole body counting	Gamma measurement (Cs-137)
Radon-222 in water	Gamma measurement or alpha measurement

6.4.4. Measurement devices available in the laboratory

- Gamma-spectrometry, the low background-activity laboratory: Nuclide specific gamma spectrometry measurements are performed using four multi channel analyzing systems with HPGE detectors, one detector from Tennelec and the other three from Canberra, with efficiencies, 18, 33.7, 45 and 52 % respectively. The electronics comes from Canberra (DSA 2000). The software Genie 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 (QA). The samples measured with gamma spectroscopy are measured for at least 24 hours.

- Liquid Scintillation: The laboratory has two low background liquid scintillation spectrometry counters, Quantulus 1220, from Wallac. Software WinQ and the analysis software EasyView are also from Wallac. The 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 5 hours.

- Whole body counting area: The laboratory is also equipped with a whole body counter laboratory with chair geometry inbuilt inside a low-activity lead container. Measurements are performed with three NaI detectors. There is also an HpGe detector for use in emergency situations. An additional NaI detector is used for thyroidal measurements. Internal doses are assessed from the activity measurements by using the software IMBA. For our control group measurements are generally 30 minutes. Thyroidal measurements are 10 minutes.

6.4.5. Measurement results

The counting and analysis procedures used during gamma spectrometry are subdivided into the categories: environmental, NPP and emergency. The 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 proper 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, Cs-137.

The environmental library contains nuclides relevant for the type of sample that is measured, including both natural and man made radionuclides.

The concentration of Sr-90 is determined from its daughter product Y-90 at equilibrium by organic extraction and Cerenkov counting in the LSC Quantulus 1220. The calculation of the activity concentration is performed in an Excel formula.

The concentration of H-3 is determined after sample preparation and then measured using the LSC Quantulus 1220. The calculation of the activity concentration is performed in an Excel formula.

Gross-alpha, gross-beta counting and Ra-226 determination in surface and drinking water is measured using the LSC Quantulus 1220. Proper adjustment of the parameter pulse shape analysis, (PSA) is performed before measurement.

Appendix 5 shows the nuclides which shall always be reported with regards to the limits of detection.

6.4.6. *Data handling and reporting obligations*

SSM maintains two databases for discharge and environmental data from the NPPs. These data are used as a base for reporting to different organisations, for evaluations and for writing reports and giving information to the public. At the moment the databases are under revision due to different problems with format and input of data and they are currently not up to date. The results have been collected and stored for future use in paper form or in excel spreadsheets.

SSM reports the results to:

- EU Euratom article 35, 36
- HELCOM
- OSPAR
- Swedish National Board of Health and Welfare
- Swedish National Food Adminstration
- Swedish Board of Agriculture
- Swedish Dairy Association
- Swedish Water & Wastewater Association

6.4.7. *Sample storage*

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

6.4.8. *Quality assurance and control procedures*

For the gamma spectrometry measurements a QA check using known references is run 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 parameters that are controlled are: peak energies, 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 $\pm2\sigma$ and $\pm3\sigma$, respectively. The QA results are stored in the system database and can be retrieved for analysis over a period of time.

Background and QA checks are done every month with the geometries of the plastic containers: Marinelli beaker 1000 ml, Sarstedt 200 ml and Cerbo 60 ml. Efficiency calibration is done with standards from Amersham in different geometries. 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 analysis over a period of time.

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

For the whole body counting measurements, calibrations are done with the phantom named "Irina", which can be built in different sizes and has the possibility of containing the sources Co-60, Cs-137, K-40 or Eu-152. The phantom Irina has also been used for inter-calibrations of the whole body counting laboratories in the Nordic countries plus the nuclear power plants in Sweden. Irina also has a neck that can be used for calibrating thyroidal measurements.

Database pointers for the measurement parameters, calibrations and measurements performed, the spectral data and the hardware electronic settings are backed up weekly on an external hard drive.

6.4.9. *Laboratory accreditation*

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 in the proficiency tests annually run by the IAEA ALMERA and also in the inter-comparisons run by the European Commission.

6.4.10. *Outsourced laboratory measurements*

Some of the discharge and site-related environmental samples are outsourced for measurements. This is controlled through a call for tenders that specifies in detail the requirements 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. Each ensuing order that is placed by SSM is accompanied by a contract.

7. THE NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

7.1. General

The SSM has issued a national environmental radioactive monitoring programme

	Nuclides*	Number of samples	Comments	Involved organisations**
National monitoring				
Particles in air	γ (^{137}Cs, ^{7}Be)	5 stations	Weekly	FOI, SSM
Surface water	^{137}Cs, total-α, total-β, $^{234, 238}$U, ^{226}Ra	2 water plants	Spring and autumn	SSM
Drinking water	^{137}Cs, ^{90}Sr, ^{3}H, total-α, total-β, $^{234, 238}$U, ^{226}Ra	6 water plants	Spring and autumn	SSM
Consumption Milk	γ (^{137}Cs), ^{90}Sr	5 dairies	4 times/year	SSM
Mixed diet	γ (^{137}Cs), ^{90}Sr	3 hospitals	Spring and autumn	SSM
Game meat (moose and roedear)	γ (^{137}Cs)	2 areas	Yearly	SLU, Gävle jaktvårdkrets, SSM
Reindeer meat	γ (^{137}Cs)	32 villages	Varying extent in different villages	SJV, SLV
Marine sediments open sea	γ (^{137}Cs)	16 stations	Every 5th year	SSM
Marine fish	γ (^{137}Cs)	8 areas	Yearly	SSM
Sea water	γ (^{137}Cs)	6 stationer	Yearly	SSM
Whole body counting	γ (^{137}Cs, ^{40}K)	2 groups	Yearly	FOI, SSM
Regional monitoring				
Some municipalities have their own programs or offer the citizens to analyse their own samples of mainly game meat, mushrooms, fish, and berries.	γ (^{137}Cs)		In many occasions rather a service to citizens than a proper monitoring program. Some data are available through web site of SSM	
Local monitoring				
Recipient control around nuclear sites. Precipitaion, natural vegetation, cultured vegetation, meat, milk, sewage sludge, water, sediment, algae, molluscs, crustaceans, fish.	γ (^{54}Mn, ^{58}Co, ^{60}Co, ^{65}Zn, ^{110m}Ag, ^{137}Cs), ^{234}U, ^{235}U, ^{238}U (onlyt Westinghouse)	In totalt 184 sampling stations on six sites	Sampling frequence between once a fortnight and once a year plus an extended program every forth year.	Nuclear facilities and SSM
Mapping projects				
Agricultural soils and crops	γ (^{137}Cs)	1250 locationss	year 2001-2010.	NV, SLU SSM
Airborne mapping of ground radiation	γ (^{137}Cs, K, U, Th)	surface covering	Ongoing	SGU, SSM

7.2. External gamma dose rate monitoring

Sweden has an automatic network of 32 stationary gamma monitoring stations throughout the country. The main purpose of the network is

- to give an alarm if there is a significant increase above the natural background gamma radiation level

- to give an instant overall picture of the radiation situation in Sweden

The measuring device consists of a pressurised ionisation chamber with a measuring range of 1-600 000 nSv/h ambient dose-equivalent rate. The average normal background level in Sweden is 100-150 nSv/h. The results are stored locally on a microcomputer, which is equipped with a modem. The main computer in SSM in Stockholm calls each gamma station over the public network 12 times per day for collecting data. The microcomputer at each station is equipped with an alarm function, which is triggered on a pre-set alarm criterion. The dose-rate is continuously integrated over a twenty-four-hour rolling period. The alarm criterion is an integrated dose-rate of 300 nSv above the preceding twenty-four-hour average. The system has shown a high degree of reliability which is important since many of the stations are in remote areas. In case of alarm, the station calls a personal pager, displaying the individual code of the station. The radiation protection officer on duty can then contact the station with a portable PC and a modem and obtain a reading.

7.3. Air related programme

7.3.1. Air monitoring stations

The National Defence Research Establishment (FOI) operates a national air monitoring network of six stations to detect particulate radionuclides in the air. In case of large increase of radioactive particles, 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. Air borne particles are collected on fibreglass filters which are sent by mail to FOIs 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 μBq/m3.

The stationary stations are supplemented 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 country governments (in counties where NPPs are located), the nuclear power stations, FOI and SSM.

7.3.2. Dry/wet deposition collectors

Sweden does not have those.

7.4. Water sampling programme

7.4.1. Surface water

Surface water is monitored in the sparse network, i.e. two stations representing the southern and the northern region of Sweden. Lake surface water from the lakes Mälaren and Storsjön are sampled as incoming water to the water plants in Norsborg and Östersund respectively. Ten to twenty liters 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 , Ra-226.

7.4.2. Drinking water

Drinking water is also sampled at water plants, but in this case as the outgoing water. In addition to the water plants in Norsborg and Östersund, samples are taken at waterplants in Göteborg, Sandviken, Luleå and Kramfors. Ten to twenty liters of drinking water is collected by the water plant personnel twice a year (spring and autumn). The samples are analysed for Cs-137, Sr-90, H-3, total-α, total-β, U-234,238, Ra-226. The analyses are conducted at the SSM and at the Studsvik facility.

Ten to twenty liters of drinking water is collected by the water plant personnel at Norsborg and Östersund twice a year (spring and autumn). The samples are analysed for Cs-137, Sr-90, H-3, total-α, total-β, U-234,238, Ra-226. The analyses are conducted at the SSM.

At the water plants in Göteborg, Sandviken, Luleå and Kramfors five liters samples are taken twice a year (spring and autumn). The samples are analysed for Cs-137, Sr-90, H-3, The analyses are conducted at the Studsvik facility.

7.4.3. Sea water

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

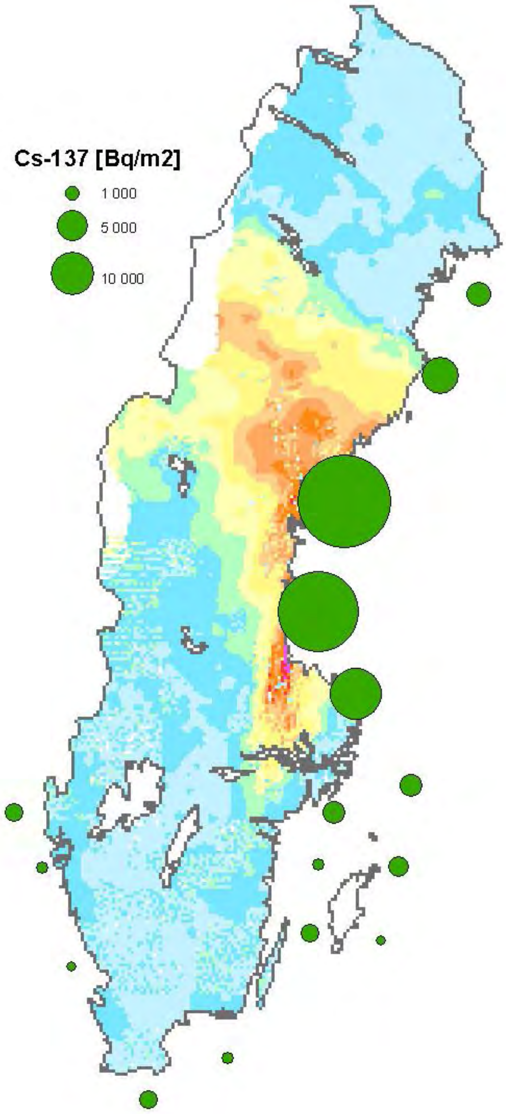
7.5. Soil related sampling programme

7.5.1. Soil and sediment

Sea sediments are collected yearly at four locations in the bothnian sea as a complement to the sediment collected within the local recipient control around nuclear facilities described in section

Sea sediments in open sea are collected every fifth year at 16 locations around the Swedish coast. Sediment cores (10 cm diameter) are sampled and sliced into 1 cm thick layers direct on the sampling vessel. Samples are freeze dried and then analysed for Cs-137.

Cs-137 in agricultural soils is currently being mapped in Sweden. Top soils (0-20 cm) will be collected at approximately 1250 locations and analysed for Cs-137. At each location, 9 subsamples are taken within a circle with a diameter of 6 meters and then combined to bulk sample. Crops at the same locations are also sampled (4 subsamples of 0,25 m2 are combined into 1 bulk sample). This mapping project is 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.



Sampling locations for sea sediments in open sea.

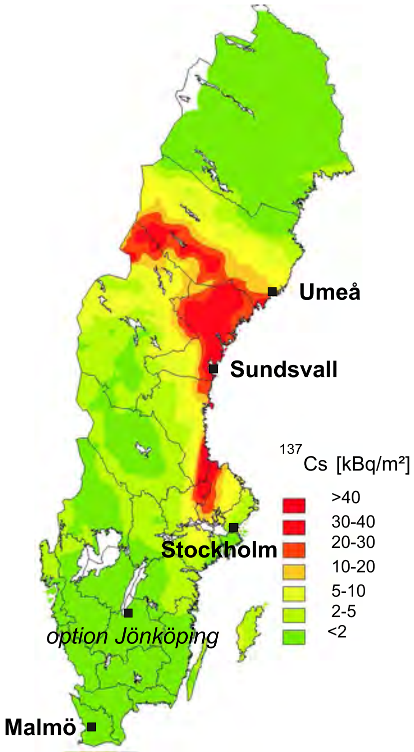
7.6. Foodstuffs sampling programme

7.6.1. For milk

The sampling programme of dairy milk has been changed at times in order to fullfill the objectives in an optimal way. The latest change was done in 2005. One of the objectives is reporting according to the article 36 of the Euratom Treaty.

Sampling locations

Sampling is done at 5 dairies. In the year 2006 these dairies covered 65 % of the dairy consumption milk production in Sweden and 78 % of the total intake of ^{137}Cs from consumption milk. The dairies are situated in Malmö, Jönköping, Kallhäll, Sundsvall and Umeå. The location of the dairies is shown in the following figure:



Sampling procedures

Random sampling is done 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. Sampling is done quarterly.

Radionuclides assessed

All of the samples from the dairies are measured for ^{137}Cs and ^{40}K. Samples from Kallhäll and Umeå are measured for ^{90}Sr. The reason for measuring only two dairies for ^{90}Sr is that the variation in the concentration in milk in different parts of Sweden is not very significant for ^{90}Sr as it is for ^{137}Cs.

7.6.2. For mixed diet

Mixed diet is collected in hospital canteens at three locations, Stockholm, Gävle and Umeå. The sampling consists of all complete meals during a 24 hours period served to a patient without any dietary restrictions. Sampling is done twice a year, in the spring and autumn. Stockholm and Umeå represents the southern and northern region in the sparse network. Gävle is sampled in accordance with the Commission recommendation 8 June 2000 on the application of article 36 of the Euratom Treaty to monitor foodstuffs which are affected by the Chernobyl fallout. ^{137}Cs, ^{90}Sr and ^{40}K are measured.

7.6.3. For foodstuffs (including wild foodstuffs)

Sampling of various foodstuffs as a mean of assessing the exposure of the population as a whole in agreement with the article 36 of the Euratom Treaty is not done presently.

Sampling is done at various regularity of meat from elks and reindeers from natural and semi-natural ecosystems.

Samples of meat from elks from two locations in middle Sweden affected by Chernobyl fall-out are each autumn measured for ^{137}Cs. Other data on e.g. roe deer is sporadically sent in to the SSM from other institutions.

Sampling of mushrooms, fresh water fish and berries is done at a local level in the districts affected most heavily by the fall-out, and reported by the local authorities to SSM at irregular intervals.

The above mentioned data is not regularly reported to the REM-data base, but after a commission request it was transmitted in 2005. It was accompanied by the following statement:

"*1. Sampling is not random over the country but biased towards areas with high Chernobyl fall-out.*
2. A single sample does not say much about the radiological impact in that area because the variation can be very large between different samples from the same area and time.
3. The sampling has not very often been made in a scientific way to be representative of an area or population. Samples have been obtained from different sources, e.g. the general public, municipalities, university laboratories and so on.
4. To be able to see trends in time of the contamination in a specific sector of the environment one has to calculate mean or median values for clusters of data within a specified time window. Each cluster may contain different numbers of data entries thus making the precision variable between different calculated mean values."

Meat from reindeers are sampled and measured according to the decision of the district veterinary at slaughter to safe guard against that meat exceeding 1 500 Bq/kg ^{137}Cs should reach the retail system. These data is reported to the SSM. We have some 400 000 data entries on reindeers which SSM has asked the guardians of the REM data base if they were of interest, but they were not.

8. LABORATORIES PARTICIPATING IN THE NATIONAL ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

All programs except that for reindeer meat are programs that SSM is running. In case there are external laboratories involved in sampling and or analysis, this is done on a commercial basis and the laboratories are reporting their results only to SSM and their responsibility are restricted to do what has been specified by SSM when ordering the service. The reindeer surveillance is run by livsmedelsverket and financed by jordbruksverket.

Program	**Laboratory**	**Contact**
Particles in air	FOI Stockholm	Karin Lind / Catarina Söderlund
Surface water	Studsvik, SSM	Charlotta Askeljung: Studsvik, Inger Östergren : SSM
Drinking water	Studsvik, SSM	Charlotta Askeljung: Studsvik, Inger Östergren :SSM
Consumption Milk	SSM	Inger Östergren
Mixed diet	SSM/Lund	Inger Östergren: SSM Christer Samuelsson, Elis Holm :Lund
Game meat (moose and roedear)	Falma provtagning, Gävle	Ulf Frykman
Reindeer meat	Div. laboratories	
Marine sediments open sea	SSM, FOI Umeå, SGU	Inger Östergren:SSM, Annika Tovedal:FOI, Ingemar Cato:SGU
Sediment	Umeå Marina Forskningscetrum	Anna Palmbo/Johan Wiknert
Sea water	SSM	Inger Östergren
Marine fish	Lund	Christer Samuelsson
Biota (HELCOM)	Riksmuséet, Stockholm	Anders Bignet
Whole body counting	SSM and FOI Umeå	Lilian del Risco Norrlind:SSM Kenneth Lidström:FOI
Agricultural soils and crops	SLU, Uppsala	Klas Rosén

FOI Umeå:

FOI
Cementvägen 20
901 82 Umeå
Contact: Annika Tovedal, tel 090 106791

SLU:

Swedish University of Agricultural Sciences
Department of Soil Sciences
PO Box 7014, SE 75007 Uppsala (visit address: Ulls väg 17, Ultuna, 75651 Uppsala)
Contact: Klas Rosén, Tel 018 671285

SGU

Sveriges geologiska undersökning,
Box 670, 751 28 Uppsala,
Contact: Ingemar Cato, tel: 018-17 90 00

9. MOBILE MEASUREMENT SYSTEMS

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

- A fixed wing airplane with one 16 l NaI and one 100% HPGe detector. The system is placed in Gävle.

- Three Chevrolet pick-up trucks with two 4 l 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 carriers with one 4l NaI and one 100% HPGe detector. The carriers are placed in Umeå, Stockholm and Gothenburg. The carriers 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 4l NaI and one 100% HPGe detector (exchangeable with the carriers).

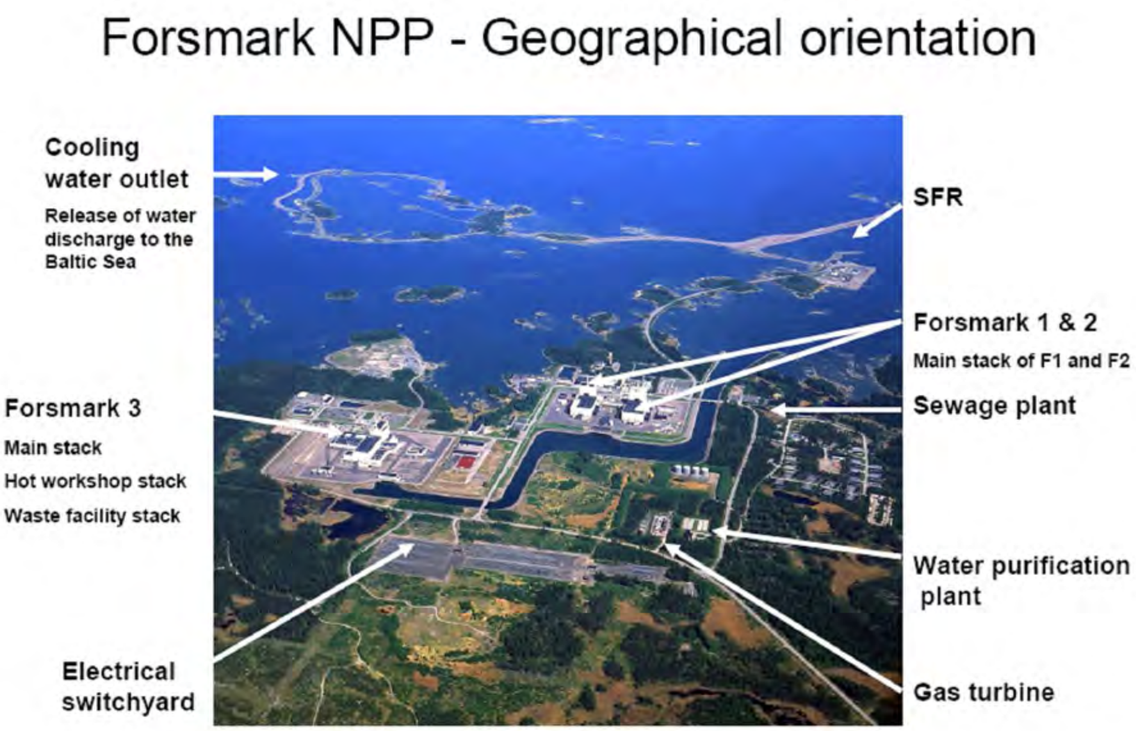
- Three backpack systems with a 3”x3” NaI detector. These systems are placed together with the trucks.

The systems have a 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 Swedish Radiation Safety Authority but operated under contract with different specialist organisation such as the Swedish Defence Research Laboratory, Radiological laboratories from the Universities and Swedish Geological Survey.

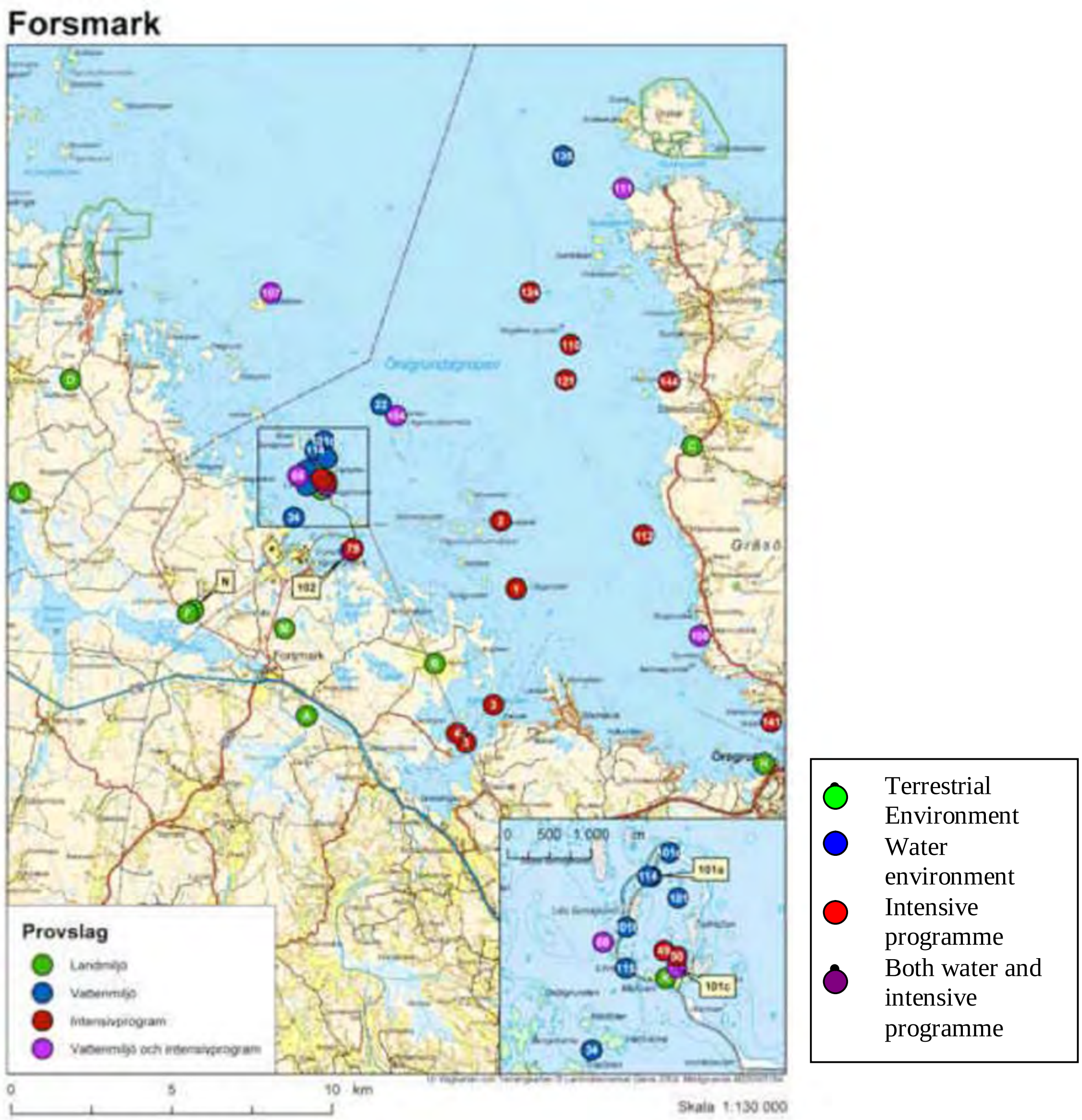
10. OTHER INFORMATION

Appendix 1


Forsmark NPP - Geographical orientation
Cooling water outlet
Release of water discharge to the Baltic Sea
Forsmark 3
Main stack
Hot workshop stack
Waste facility stack
Electrical switchyard
SFR
Forsmark 1 & 2
Main stack of F1 and F2
Sewage plant
Water purification plant
Gas turbine

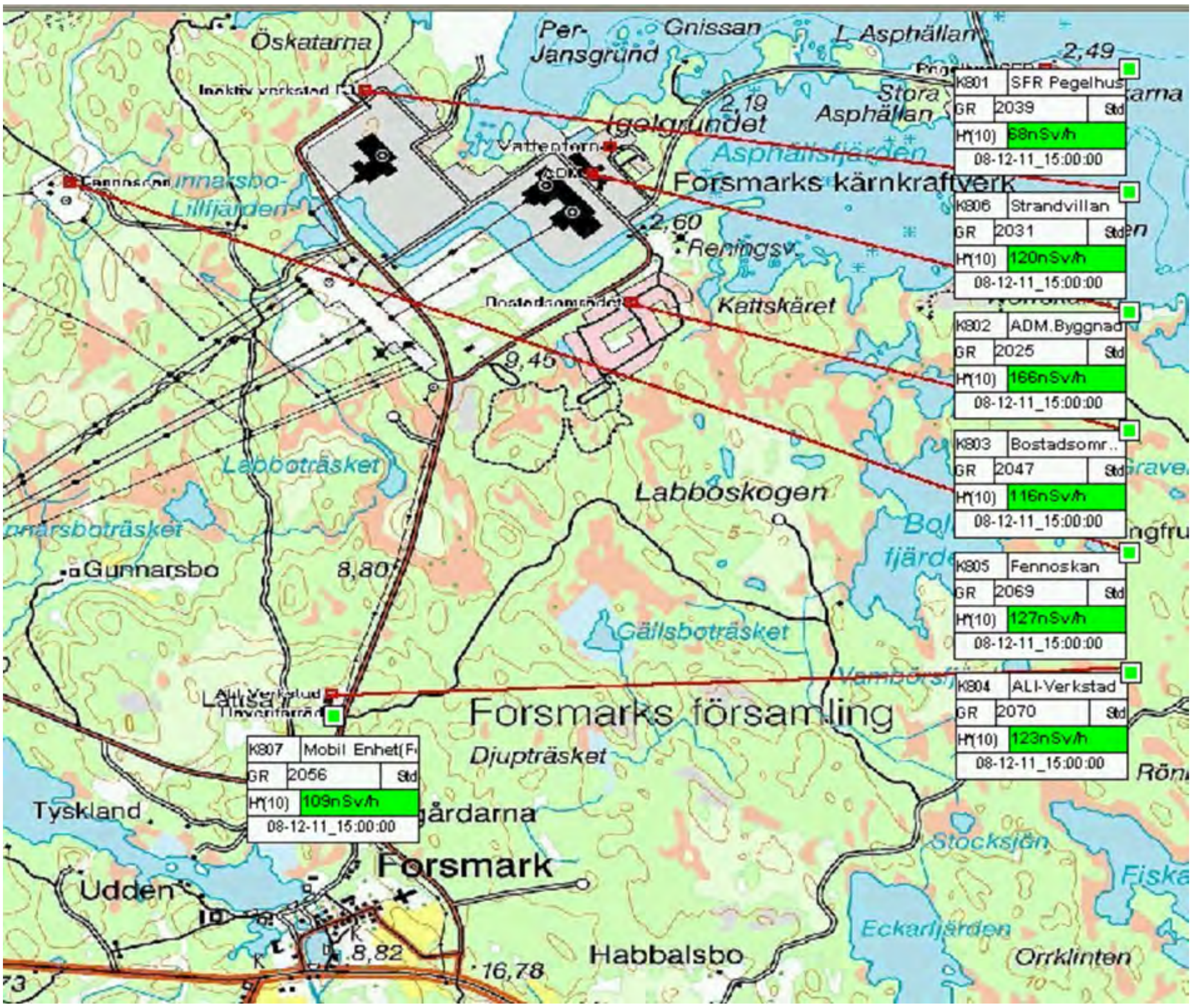
Appendix 2

Environmental sampling stations in the vicinity of Forsmark NPP



Appendix 3

Map of the dose rate monitors (Genitron-system) placed in the near vicinity of the Forsmark NPP



Appendix 4

Detection limits for nuclide specific gamma detection (553 K905, 906 and KB741, KD742

Nuclide	Tot. Bq	0-1 years	1-2 yr	2-7 yr	7-12 yr	12-17 yr	Adult	Max
AR-41	1,0E+12	6,5E-07	6,5E-07	6,5E-07	6,5E-07	6,5E-07	6,5E-07	6,5E-07
KR-85M	1,1E+12	8,2E-08	8,2E-08	8,2E-08	8,2E-08	8,2E-08	8,2E-08	8,2E-08
KR-87	1,6E+12	6,4E-07	6,4E-07	6,4E-07	6,4E-07	6,4E-07	6,4E-07	6,4E-07
KR-88	3,4E+12	3,7E-06	3,7E-06	3,7E-06	3,7E-06	3,7E-06	3,6E-06	3,7E-06
KR-89	3,8E+12	1,7E-06	1,7E-06	1,7E-06	1,7E-06	1,7E-06	1,7E-06	1,7E-06
XE-131M	3,9E+13	1,5E-07	1,5E-07	1,5E-07	1,5E-07	1,5E-07	1,5E-07	1,5E-07
XE-133	7,8E+12	1,2E-07	1,2E-07	1,2E-07	1,2E-07	1,2E-07	1,2E-07	1,2E-07
XE-133M	7,4E+12	1,0E-07	1,0E-07	1,0E-07	1,0E-07	1,0E-07	1,0E-07	1,0E-07
XE-138	3,9E+12	2,3E-06	2,2E-06	2,2E-06	2,2E-06	2,2E-06	2,2E-06	2,3E-06
XE-135	9,9E+11	1,2E-07	1,2E-07	1,2E-07	1,2E-07	1,2E-07	1,2E-07	1,2E-07
XE-135M	2,6E+12	3,9E-07	3,9E-07	3,9E-07	3,9E-07	3,9E-07	3,9E-07	3,9E-07
XE-137	4,7E+12	1,0E-07	1,4E-07	1,6E-07	1,8E-07	2,1E-07	1,9E-07	2,1E-07

(F3)) Values are calculated for old system, 2007. (Tot. Bq or mSv)

Appendix 5

Nuclide library for environmental samples

Nuclide	**Half life**	**Limits of detection shall always be reported**	**note**
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 Via Ba-137m
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		

Appendix 6

List of abbreviations

BWR	Boiling water reactor
F1	Forsmark unit 1
F2	Forsmark unit 2
F3	Forsmark unit 3
FKA	Forsmark Kraftgrupp AB
GM- detector	Geiger-Müller detectors
NaI (Tl)-detector	Tl- doped NaI crystal scintillation detectors
Cps	Counts per second
Cpm	Counts per minute
HPGe-detector	High purity germanium semiconductor detectors
SPG-detector	Self Powered Gamma detector
SSM	Swedish Radiation Safety Authority
SMHI	Swedish Meteorological and Hydrological Institute
PDB-system	Process database system
FTK	The chemistry department at Forsmark NPP
PM-tube	Photomultiplier tube
HDEHP	Bis-(2-Ethylhexyl) Phosphoric Acid
FQ	Department of safety and environment at Forsmark NPP

Appendix 7

Avd för beredskap och miljöövervakning	2007-11-23	2007/3876
	Ert datum	Er referens
Avd för radiofysik Lunds universitetssjukhus 221 85 Lund		Elis Holm

OFFERTFÖRFRÅGAN 2008

Avdelningen för Beredskap och Miljöövervakning vid Statens strålskyddsinstitut, SSI och från 2008-07-01 den nya strålsäkerhetsmyndigheten önskar en offert på följande mätningar. I offerten ska pris per analys och en totalkostnad som inkluderar eventuella provberedningar och administrativt arbete ingå. Offerten avser analyser på ”Omgivningsprover”, ”Helcom”, ”Matkorgar” och ”Eventuella nuklidspecifika analyser”. Ny upphandling kommer att göras för 2009. I offerten ska ingå en kort beskrivning av analysmetod, mätutrustning och mättider och ett exempel på hur felen räknas ut. Mätosäkerheten anges som standardmätosäkerhet enligt EAL-R2-Sv (1999). Ett krav finns på att MDA beräknas enligt Currie (1968). Används analysprogrammet Genie 2000 så finns dessa krav i programvaran.

SSI är certifierade enligt miljöledningssystem ISO 14001.Vi vill därför att ni redovisar vilket miljöarbete ni bedriver. I redovisningen ska ingå hur ni säkerställer att ni följer lagar och andra krav på miljöområdet. Vi kommer att följa upp hur våra leverantörer lever upp till redovisat miljöarbete. Läs mer om SSI:s interna miljöarbete på www.ssi.se. om ssi/kvalitets och miljöarbete.

Svar på offertförfrågan adresserat till Inger Östergren önskas senast 2008-01-14

Omgivningsprover

Runt kärnkraftverken	Max 45 prover fördelade under våren/hösten. Provberedning, gammamätning och rapportering enligt bilaga (Nuklidbibliotek). Analysresultat skickas i Excelformat till SSI efter avslutad mätomgång, märkta med diarienumret på avtalet. ID-koden på vilket prov som analysen avser ska vara tydlig och insamlingsdatum. Analyssvar och faktura ska vara SSI tillhanda senast 2 mån efter att provet inkommit.
Blandad kost	Insamling och provberedning av 3 flytande och 3 fasta prover av dygnskonsumtion från sjukhuskök i Umeå, Gävle och Stockholm. Totalt 12 prover. Efter gammamätning ska de torkade proverna var för sig skickas till SSI (OBS inaskas ej) Cs-137, K-40 analyser separat på de fasta och flytande proverna. Mättid minst 2 dygn. Prover ska tas vår (april) och höst (september). Resultaten ska rapporteras både i Bq/kg våt- och torrvikt, samt Bq/dag våtvikt.

För att kunna göra interna beräkningar behöver vi också få de faktiskt uppmätta eller maxvärden även om det är stora osäkerheter.

	MÄTKRAV	**MÄTKRAV**
Nuklid	Detektionsgräns Bq/kg	Mätosäkerhet 1 SD Bq/kg
Cs-137	<0,07	0,035 eller <10 %
K-40		± 5 Bq/kg

Analysresultat skickas i Excelformat till SSI efter avslutad mätomgång, märkta med diarienumret på avtalet och ID-koden på vilket prov som analysen avser ska vara tydlig, samt kopia på matsedel och insamlingsdatum och den totala vikten på det fasta och flytande provet. Analyssvar och faktura ska vara SSI tillhanda senast 2,5 mån efter att provet inkommit, 1/7-08 och 1/12-08.

Helcom
Biota

ca 20 prover. Gammamätningar på fisk och andra prover. Max 60 g styck. Provberedning, gammamätning och rapportering enligt bilaga (Nuklidbibliotek)
Analysresultat skickas i Excelformat till SSI efter avslutad mätomgång, märkta med diarienumret på avtalet och ID-koden på vilket prov som analysen avser samt provdatum. Analyssvar och faktura ska vara SSI tillhanda senast 2 mån efter att provet inkommit.

Helcom
Sediment

Max 30 prover en gång under våren. Proverna levereras torkade i Cerbo-60. Gammamätning och rapportering enligt bilaga (Nuklidbibliotek)
Analysresultat skickas i Excelformat till SSI efter avslutad mätomgång, märkta med diarienumret på avtalet och ID-koden på vilket prov som analysen avser samt provdatum. Analyssvar och faktura ska vara SSI tillhanda senast 2 mån efter att provet inkommit.

Nuklidspecifika
Analyser

Vid behov analysera nuklidspecifika mätningar på U eller Pu eller båda. Preliminär prisuppgift önskas.

För Statens strålskyddsinstitut

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Verksamhetschef Lab.ing
Telefon: 08-729 7260 Telefon: 08-729 7212

Avdelningen för strålskydd 2008-07-05 Dnr SSM 2008/793

Datum Er referens

Lunds Universitet Medicinsk strålningsfysik Elis Holm
Barngatan 3
221 85 Lund

Beställning av analyser
Strålsäkerhetsmyndigheten (SSM) beställer härmed rubricerat uppdrag tom 2008-12-31. Beställningen, med de specifikationer samt övriga villkor som framgår nedan, är inte bindande förrän SSM mottagit ett exemplar av detta beställningsbrev, av de två översända, undertecknat av behörig person hos uppdragstagaren.
Denna beställning, undertecknad av strålsäkerhetsmyndigheten och uppdragstagaren, utgör avtal för uppdraget.

Uppdragets omfattning
Enligt anbudsförfrågan 2007\3876-41. Antalet analyser och kostnader är beräknade för hela 2008
Max 45 analyser på omgivningsprover. Max kostnad 67 500:- kronor.
Totalt 8 analyser på blandad kost. Total kostnad 12 000:- kronor.
Max 20 analyser på Helcom biota. Max kostnad 30 000:- kronor.
Eventuella nuklidspecifika analyser.
Väsentliga ändringar i inriktning och tidsplan får göras endast efter samråd med SSM.

Leveransvillkor
Enligt anbudsförfrågan 2007\3876-41

Betalningsvillkor
Priset inkluderar samtliga kostnader för uppdragets utförande.
Fakturering skall ske till SSM enligt anbudsförfrågan 2007-\3876-41
Fakturan skall innehålla uppgifter om universitet, organisationsnummer och fakturadatum. Av fakturan skall vidare framgå uppdragets diarienummer.

Betalning sker 30 dagar netto efter godkänd fakturas ankomstdag. Vid felaktiga uppgifter på fakturan återsändes den till uppdragstagaren utan åtgärd för rättelse. Inga administrativa avgifter betalas. Vid eventuell försenad betalning som beror på SSM accepteras dröjsmålsränta enligt räntelagen.

Miljökrav
SSM är certifierat enligt ISO 14 001, AFS 2001 och ISO 9001. Genomförandet av uppdraget får inte negativt påverka SSM betydande miljöaspekter för indirekt och direkt miljöpåverkan.

Ansvar
Uppdragstagaren ansvarar för direkt skada som orsakats genom fel eller försummelse av honom, dennes personal/underkonsulter eller i övrigt av uppdragstagaren anlitade.
När SSM så begär skall brister i åtagandet från uppdragstagaren, orsakade genom avvikelser från detta avtal, åtgärdas av uppdragstagaren. Åtgärderna skall utföras utan oskäligt uppehåll och utan tillkommande kostnader för SSM.

Äganderätt, immateriella rättigheter, uppfinningar och patent
SSM erhåller genom detta avtal fullständig ägande- och nyttjanderätt till allt material och alla resultat som genereras genom uppdraget. Denna rätt gäller även i förhållande till av uppdragstagaren anlitade underleverantörer
Upphovsrätt gäller enligt upphovsrättslagen (1960:729).

Sekretess
Uppdragstagaren får inte röja eller utnyttja sekretessbelagd uppgift och skall i förekommande fall informera sig om innebörden av sekretesslagens bestämmelser om bl.a. tystnadsplikt. Uppdragstagaren förbinder sig också att se till att personal eller anlitande underkonsulter gör motsvarande åtaganden.

Hävning
Endera parterna har rätt att med omedelbar verkan häva detta avtal i fall någon av parterna väsentligen bryter mot avtalet, samt rättelse inte skett inom trettio (30) dagar efter skriftlig anmaning. Om SSM finner att arbetet inte bedrivs på tillfredsställande sätt eller om avsevärda förseningar kan befaras, äger SSM rätt att avbryta beställningen och betala endast för utfört arbete.

Tvist
Tvist i anledning av detta avtal skall i första hand avgöras genom förhandling mellan parterna och i andra hand av svensk domstol med tillämpning av svensk rätt.
Den omständigheten att tvist hänskjuts till rättslig prövning berättigar inte uppdragstagaren att avbryta uppdraget. Inte heller äger SSM att på sådan grund innehålla belopp som inte direkt omfattas av tvisten.

Omförhandling
Parterna får påkalla omförhandling av ingånget avtal om förhållandena under avtalsperioden väsentligt skulle komma att avvika från vad som gällde när avtalet träffades.
SSM har rätt att skriftligen begära omförhandlingar av avtalsvillkoren om nya tekniska lösningar införs för beställning eller expediering av tjänster och dessa lösningar ändrar förutsättningarna för verksamheten eller kostnaderna för verksamheten.

Ändringar och tillägg
Ändringar och tillägg till detta avtal skall för sin giltighet skriftligen vara godkända av båda parter.

Övrigt
Detta avtal får inte överlåtas på annan av uppdragstagaren utan SSM:s medgivande.

Godkännes

För uppdragstagaren:		**För Strålsäkerhetsmyndigheten**	
Datum:	Ort:	Datum:	Ort:
Namn:		Namn:	
Namnförtydligande:		Namnförtydligande:	

Strålsäkerhetsmyndigheten
Swedish Radiation Safety Authority

SE-171 16 Stockholm
Solna strandväg 96

Tel: +46 8 799 40 00
Fax: +46 8 799 40 10

E-mail: registrator@ssm.se
Web: stralsakerhetsmyndigheten.se