SSI Rapport

SSI report

2001:24

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Evaluation of the laboratory resources of the Swedish Radiation Protection Institute

The balance between internal and external laboratory capacity

Statens strålskyddsinstitut
Swedish Radiation Protection Authority

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TITLE/ TITEL : Evaluation of the laboratory resources of the Swedish Radiation Protection Institute. The balance between internal and external laboratory capacity/ Statens strålskyddsinstituts framtida behov av mätresurser för strålning och radioaktivitet. Avvägning mellan egna och upphandlade resurser.

SUMMARY: The Swedish Radiation Protection Institute (SSI) has by directive of September 4, 2000 from the Director-General initiated an evaluation of SSI's future needs for laboratory resources regarding measurements of radiation and radioactivity. The present document is the final report by the external independent evaluation panel, as presented at SSI, 23 August 2001. The evaluation panel has made assessments of SSI's obligations concerning laboratory related tasks according to the Swedish legislation, international commitments, and SSI's vision. The assessments also comprise SSI's present laboratory resources and SSI's system of external contract laboratories. Finally, aspects of outsourcing of laboratory resources from SSI are discussed. The evaluation panel finds that SSI's high international level of competence has a basis in research and innovative skills in radiation protection where results from SSI's own laboratory work and measurements has played a fundamental role. The panel recommends SSI to retain, and in some areas strengthen, key laboratory activities. The panel finds that the system of contract laboratories are well established with a high level of expertise and with adequate equipment. These laboratories play an important role in the Swedish emergency preparedness system. The panel recommends to introduce small scale emergency exercises for the contract laboratories without previous warning. It is also recommended to concentrate the efforts on fewer and larger contract laboratories in order to strengthen the continuity.

SAMMANFATTNING: Statens strålskyddsinstitut (SSI) påbörjade genom beslut av generaldirektören 2000-09-04 en utredning av sina kommande behov av laboratorieresurser för mätning av strålning och radioaktivitet. En utredningsgrupp, bestående av tre utomstående experter, gav 2001-08-23 detta dokument som sin slutrapport. Utredningsgruppen har klarlagt SSI:s laboratorierelaterade skyldigheter utgående ifrån svensk lagstiftning, internationella åtaganden och SSI:s egen framtidsvision. Utredningen omfattade också SSI:s nuvarande laboratorieresurser och institutets system med externa kontraktslaboratorier. Vidare framfördes synpunkter på utlokalisering av SSI:s laboratorieresurser till externa (upphandlade) tjänster. Utredningsgruppen anser att SSI:s höga internationella kompetensnivå är baserad på forskning och innovativa färdigheter inom området strålskydd, där resultat från SSI:s eget laboratoriearbete och egna mätningar har spelat en grundläggande roll. Utredningsgruppen rekommenderar SSI att fortfarande upprätthålla, och i vissa fall stärka, sina centrala laboratorieresurser. Systemet med kontraktslaboratorier bedöms vara väl inkört med hög kompetensnivå och tillräckliga resurser. Kontraktslaboratorierna har en viktig roll i den nationella strålskyddsberedskapen. Utredningsgruppen rekommenderar att laboratoriernas beredskap prövas genom övningar i liten skala utan föregående varning. Den långsiktiga kompetensförsörjningen kunde också effektiveras genom att satsa på färre och större kontraktslaboratorier.

Statens strålskyddsinstitut
Swedish Radiation Protection Authority

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I. Introduction

I.1 DIRECTIVE FROM THE DIRECTOR-GENERAL

The Swedish Radiation Protection Institute, SSI, has by decision of September 4, 2000 initiated an evaluation of SSI's future needs for laboratory resources regarding measurements of radiation and radioactivity. By directive from the Director-General (Appendix A), the evaluation task was assigned to SSI's Department of Environmental and Emergency Assessment and an external independent evaluation panel. As described in the directive, the aim is to ensure an economically efficient organisation for the measurement of radiation and radioactivity in samples, in the environment, and in man, i.e. laboratory activities and resources that correspond to SSI's needs and obligations in the coming decennium.

As a part of the evaluation, mapping of the relevant existing Swedish laboratories is required. The mapping should include an analysis of the role of the laboratories in relation to the emergency preparedness system, the environmental surveillance, and the regulatory function regarding radiation protection. In addition, the quality, resources, and permanency of the laboratories in question should be evaluated.

Two scenarios are outlined in the directive: One in which SSI continues to operate its own laboratory facilities, and one in which SSI relies entirely on external services and laboratory facilities. For each scenario, an economic analysis of the laboratory activities should arrive at the cost per year under normal conditions and the cost per measurement produced.

The following evaluation panel was established during October 2000:

Anders Damkjær (chairman)
Head of Radiation Protection and Reactor Safety Programme,
Nuclear Safety Research Department,
Risø National Laboratory, Denmark.

Gunnar Saxebøl
Director, Health Physics Department,
Norwegian Radiation Protection Authority, Norway.

Michael Tillander
Laboratory Manager, Laboratory of Radiochemistry,
Department of Chemistry,
University of Helsinki, Finland.

As SSI's representative in the evaluation work was assigned:

Hans Mellander
Head of Department of Environmental and Emergency Assessment,
SSI, Sweden.

The present document is the final report by the evaluation panel, as presented at SSI, 23 August 2001.

I.2 AMENDMENTS SUGGESTED BY THE EVALUATION PANEL

Initial discussions in the panel concluded that the evaluation project described in the directive is two-fold:

Firstly, an analysis of SSI's need for laboratory capacity is required, including an analysis of the best balance between internal and external laboratory resources in order for SSI to meet its obligations. This will also include a number of principal discussions concerning SSI's mission and credibility as the regulatory authority. The evaluation group regarded this part of the project as the central task of the evaluation.

Secondly, mapping of relevant Swedish laboratories, their abilities and their costs to meet specified demands concerning tasks and standards is required. This part of the project is primarily of a technical-economical nature and may involve legal call for tenders according to EU legislation.

Consequently, it was suggested to the SSI Director-General that the evaluation panel deals with the first part of the project and aims at a recommendation concerning the balance between internal and external laboratory resources, assuming *a priori* that outsourcing of laboratory capacity is cost-effective. The second part of the project, mapping of relevant Swedish laboratories, should be carried out by SSI. The Director-General accepted this suggestion. Accordingly, the terms of reference for the evaluation group was henceforth:

> *An analysis of SSI's need for laboratory capacity and the best balance between internal and external laboratory resources in order for SSI to meet its obligations. The analysis will include an evaluation of the necessary capacity for measurements and the present system of contract laboratories. In addition, the analysis should include a discussion of SSI's mission regarding laboratory work, SSI's credibility as the regulatory authority, the possible conflicts of interest involved in the balance between internal and external laboratories, questions of continuity and possible vulnerability of external laboratories, and long term quality assurance and quality control.*

(Translation of task I, letter to DG, Lars-Erik Holm, 20 March, 2001 (appendix A))

I.3 THE EVALUATION PROCEDURE

In accordance with the terms of reference, sec. I.2., the evaluation comprised assessments of the following aspects:

- SSI's obligations concerning laboratory related tasks according to the Swedish legislation, international commitments, and SSI's vision.
- SSI's present laboratory resources and their adequacy in relation to SSI's obligations.
- SSI's system of contract laboratories.
- Aspects of outsourcing of laboratory resources from SSI.

Three meetings at SSI in Stockholm, five visits to SSI-contract laboratories, and 67 documents formed the background for the assessments of the evaluation panel:

1st Meeting, 19 December, 2000:
The panel met with SSI's Director-General Lars-Erik Holm, and SSI representatives Ulf Bäverstam, Hans Mellander, Rolf Falk, and Olof Karlberg.

2nd Meeting, 6 - 7 March, 2001:
The panel met with SSI representatives Ulf Bäverstam, Hans Mellander, and Rolf Falk. During the meeting the panel visited SSI's laboratories.

3rd Meeting, 2 - 3 May, 2001:
The evaluation panel met with representatives for SSI's laboratory staff: Lynn Hubbard, Lars Mjönes, Nils Hagberg, Anders Glansholm, Leif Moberg, Wolfram Leitz, and Jonas Lindgren.

Also, the panel met with representatives from the unions: Synnöve Sundell-Bergman (Akademikerns Centralorganisation SACO), Inger Östergren (Statstjänstemannaförbundet), and Göran Samuelsson (Statstjänstemannaförbundet).

The panel visited the following contract laboratories:

Avdelningen för radiofysik, Jubileumsinstitutionen, Lunds universitet
Universitetssjukhuset
SE-221 85 LUND

Studsvik Nuclear AB
SE-611 82 NYKÖPING

Totalförsvarets forskningsinstitut (FOI), Enköpingsvägen 126
SE-172 90 STOCKHOLM

Avdelningen för NBC-skydd, Totalförsvarets forskningsinstitut (FOI)
SE-901 82 UMEÅ

Institutionen för strålningsvetenskaper, radiofysik, Umeå universitet, Universitetssjukhuset
SE-901 85 UMEÅ

By agreement between the evaluation panel and SSI, the present evaluation report is published as a SSI report.

A list of all the background documents for the evaluation is found in appendix C.

II. SSI today

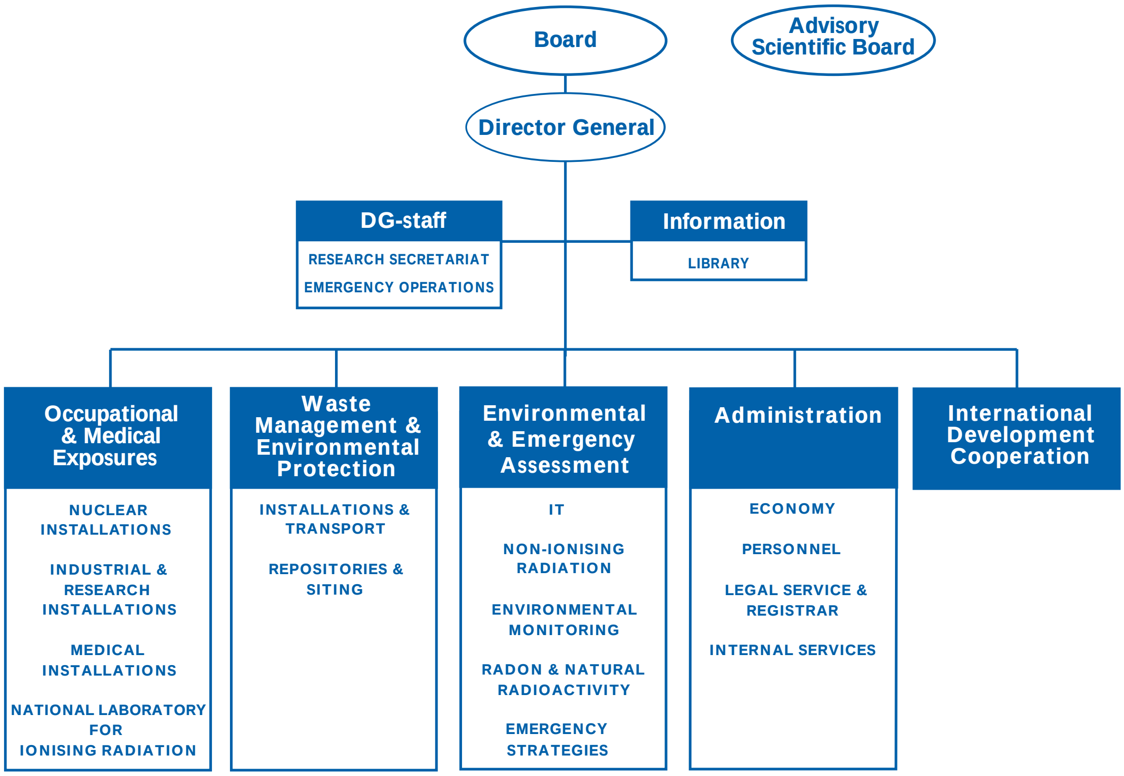
II.1 OVERVIEW

The Swedish Radiation Protection Institute, SSI, is the regulatory authority regarding radiation protection in Sweden. It is the task of SSI to protect people and the environment from the harmful effects of radiation and to ensure that the risks and benefits inherent to radiation and its use are compared and evaluated. SSI implements the dose limits for the general public and for workers and issues and control regulations through inspections. SSI provides information, education, and advice to the public and to institutions. SSI carries out research and administers external research projects. SSI participates on a national and international level in the field of radiation protection. A special SSI project called SSI's International Development Cooperation (SIUS) contributes to the improvements in radiation protection standards primarily in the former Soviet states.

SSI has the co-ordinating responsibility in Sweden in case of a radiological accident. In that event, a special emergency preparedness organisation comes into operation. Early notification of emergencies is obtained from automatic alarm monitoring stations in Sweden and abroad and through international and bilateral agreements on early warning and information.

More information about SSI is available at the SSI home page **http://www.ssi.se**

Organisation



SSI is organised under the Ministry of Environment. The internal structure is illustrated in the organisational diagram above. In total 110 persons work at SSI with professionals in physics, medicine, chemistry, techniques, biology, legislation, and information. The annual budget is of the order 100 million SEK.

The Director-General of SSI, and the board of SSI are appointed by the Government. SSI has five departments, two of which are involved with laboratory and measuring activities i.e. the Department of Occupational and Medical Exposures and the Department of Environmental and Emergency Assessment. The National Standards Laboratory (Riksmätplats) was excluded from the evaluation panel's task, and the laboratory activities in this unit are not included in Table 2-1 nor discussed below.

SSI's present laboratory activities
SSI has today laboratory activities in eight different main areas. These are denoted:

1. Radiochemical laboratory, alpha + beta
2. Radon laboratory
3. Non-ionising laboratory, Electromagnetic fields
4. Non-ionising laboratory, Optics
5. X-ray medical diagnostic laboratory
6. Gamma-laboratory
7. Whole body laboratory
8. Field-gamma/GIS laboratory.

The functions of these laboratory facilities are several but a grouping of these used by SSI is:

- Inspections
- Emergency preparedness
- Environmental surveillance
- Research
- Quality assurance
- Other.

Personnel

The total work force at SSI is 110 employees. In the laboratories there are several groups of professionals with varying formal competence and many work only partially with laboratory activities. The following table shows the distribution of active working hours in the laboratories and the distribution of the laboratory work according to SSI's grouping as indicated in the left column. The total work spent on pure laboratory activities at SSI is ca. 10.000 working hours or of the order 6 man-years. Thus, the internal laboratory work at SSI amounts to 5,5 % of the total workforce. This does not, however, include the data handling and administration associated with the laboratory activities.

Table 2.1. Distribution of work hours per year on laboratories and functions.

Laboratory/ Function	Radiochemical Alpha+beta	Radon	El.-Mag. Fields	Optics	Med. X-ray	Gamma	Whole body	Field gamma
Inspection	303	860	85	155	120	1122	30	0
Preparedness	0	0	0	0	0	73	150	450
Surveillance	244	0	165	965	0	160	180	204
Research	135	940	400	75	40	279	140	700
Q.A.	183	325	20	100	0	443	30	200
Other	436	200	0	30	0	70	30	50
Sum	1301	2325	670	1325	160	2147	560	1604

II.2 SSI's OBLIGATIONS CONCERNING LABORATORY RELATED TASKS

Legislation

SSI's tasks are defined through national legislation, regulations and official instructions from the government. (SFS 1988:220 Strålskyddslag i sin lydelse 2000-05-13, SFS1988:295 Förordning med instruktion for Statens strålskyddsinstitut i sin lydelse 2000-12-01). According to these regulations some of SSI's tasks points directly or indirectly to activities in relation to radiation measurements. In particular SSI shall:

- Obtain accurate knowledge about risks associated with radiation and **with care follow the development in knowledge in the field of biological effects of radiation and radiation physics.**
- **Co-ordinate** national radiation protection interests and work.
- **Be prepared** for consultative functions towards other authorities with public protection responsibilities with domestic or foreign nuclear accident situations.
- **Have responsibility** for the long-term follow up of sanitation.
- Have a **co-ordinating** responsibility in targeted radiation protection research.
- **Execute** targeted research and development in the field of radiation protection.
- **Inform** about radiation, its features and applications, and radiation protection.
- **Monitor** and evaluate the radiation exposure of the population as a whole and for critical groups.

The co-ordinating role of SSI in the field of nuclear emergency preparedness is clear and evident both in special governmental instructions and regulations. This co-ordinating role has been implemented through consultation and education towards the municipal units as well as assistance in purchasing and testing instruments. In addition a great deal of the nuclear emergency preparedness tasks have been contracted out to a number of laboratories throughout Sweden. This co-ordination role of SSI in the nuclear emergency preparedness points to an obligation for SSI's measuring and laboratory functions since it seems to be expected that SSI also shall have a main role in the quality management and quality assurance of the relevant measurements.

On an annual basis SSI receives from the Government, Ministry of Environment, a letter of instructions that describes the activities SSI shall perform each budget year and the elements to be included in the system of reporting to the ministry (Regleringsbrev för budgetåret 2001 avseende Statens strålskyddsinstitut). For 2001 three main activity areas are specified:

1. Nuclear emergency preparedness and inspections of nuclear facilities**[GS2][GS3]**
2. General inspections of practices
3. Environmental surveillance

These three main activity areas are further divided into 7 activity sub areas. In addition 2 sub areas dealing with more general activities are described. A key element in the reporting for these activity areas is that SSI shall describe, as appropriate, the inspections, the measures taken, and programs and research efforts carried out in order to achieve:

- *Prevention* of accidents/incidents and acute radiation damage and keeping radiation doses to workers and the general public as low as reasonably achievable.
- *Evaluation and limitation* of the risks associated with handling and disposal of used nuclear fuel and radioactive waste.
- *Maintenance and development* of nuclear emergency preparedness nationally and internationally.
- *Strategies* for monitoring patient doses and implementation of reference levels.
- *Assessment and reduction* of exposure to natural ionising radiation in the workplace and in dwellings.
- *Prevention and risk reduction* of acute and late health damage to the public from non-ionising radiation exposure.
- *Monitoring* of the environment regarding radioactivity and changes in radiation levels on land, in water, in air and in inhabited areas.
- *Continuation* of SSI's status and function as the Swedish national dosimetry standard laboratory.
- *Inform and educate* the public and target groups about radiation and the associated risks.

EU directives
With respect to the obligations laid down in the two relevant EU-directives, Council directive 96/29 Euratom of 13 May 1996 and Council directive 97/43 Euratom of 30 June 1997, hereafter called BSS and MED respectively, it is to be noted that the directives have to be implemented by the member states through legislation, regulations and administrative provisions, article 55 and 57 in BSS and article 14 and 16 in MED. Thus, all obligations defined in BSS and MED has to be channelled through the national obligations laid down in the Swedish legislation.

The directives do not describe how the infrastructure concerning radiation protection should be organised in the member states neither do they describe the necessary laboratory activities. The member states are in many ways free to organise their laboratory activities that fit best nationally, provided certain goals and provisions are met. Many of the provisions imply measurements and laboratory facilities but not necessarily carried out at the authority's own laboratories. Examples of provisions in the BSS that might or could require measurements or laboratory analysis at the regulatory authority's own facilities are the following:

- *Verification* through measurements could be necessary in order to comply with
  - article 3, clause 2 concerning 'no reporting' in connection with exemption levels etc.
  - article 4 concerning 'prior authorisation' with respect to operation and decommissioning of any facility of the nuclear fuel cycle and deliberate addition or administration of radioactive substances to products or persons etc.
  - article 6 concerning '…justified in advance of being first adopted…' addressing the general principles of justification, optimisation and dose limitation for practices
  - article 29 concerning 'individual monitoring' of workers etc. and
  - article 44 concerning 'conditions for authorisation of practices involving a risk from ionising radiation for the population'.
- *Surveillance, monitoring and/or assessment* through measurements could be necessary in order to comply with
  - article 14 'exposure of the population as a whole', shall be regularly assessed
  - article 18 clause 3 'establish guidance…' on the classification of controlled/ supervised areas
  - article 24 'working environment' related to external dose rates, air activity concentrations and surface contamination
  - article 25 'individual monitoring' and
  - article 45 on 'estimates of population doses'. This aspect is additionally specified in more detail in a Commission Recommendation of 8 June 2000 issued with reference to article 36 in the Euratom treaty where the competent authorities are reminded through article 45 of BSS to ensure that dose estimates for the population as a whole are made as realistic as possible.
- *Inspection* including measurements could be necessary in order to comply with article 38 'a system or systems of inspections' and article 46 as regards the health protection of the population in normal circumstances.
- *Identification of new radiation protection areas* through measurements could be necessary in order to comply with article 40, clause 2 as regards significant increase in exposure due to natural sources.
- *Intervention* based on measurements could be necessary in order to comply with article 50 'intervention preparation', article 51 'implementation of intervention' and article 53 'intervention in cases of lasting exposures'.

Examples from the MED directive that might or could require measurements or laboratory analysis at the regulatory competent authority's own facilities are:

- *Verification and surveillance* through measurements in order to comply with article 3 and 4 concerning different types of justification and optimisation questions and also in order establish proper reference levels and dose constraints. Similarly situations may occur where the competent authority should perform measurements on equipment according to article 8.
- *Inspection* including measurements could be necessary in order to comply with article 13 'a system or systems of inspections' and article 12 as regards estimates of population doses.

International co-operation

SSI has outstanding traditions with international co-operation in the field of radiation protection. The international status of SSI is highly respected and SSI is a driving force for international co-operation and progress in this field. The basis for that situation has been the high level of competence, research and innovative skills in radiation protection where results from SSI's own laboratory work and measurements has played a fundamental role. Certainly SSI also use international co-operation as a method to meet the obligation to 'obtain accurate knowledge about risks associated with radiation and with care follow the development in knowledge in the field of biological effects of radiation and radiation physics'. In recent years special attention has been given to the development of radiation emergency preparedness in the Baltic States.

The international organisations where SSI plays an active role are listed below

- EU (European Union)
- IAEA (International Atomic Energy Agency)
- ICRP (International Commission on Radiation Protection)
- NKS (Nordic Nuclear Safety Research)
- OECD/NEA (OECD's Nuclear Energy Agency)
- WHO (World Health Organisation)

The contribution from SSI to international co-operation is certainly highly appreciated among other partners. Hopefully this work will continue and also in the coming decennium have a basis in SSI's research and laboratory work. This internationally recognised status is also an important factor for SSI's domestic credibility. To underline SSI's authority the panel suggests that SSI considers to change its name in English to 'Swedish Radiation Protection Authority'.

II.3 SSI's VISION

The long-term goal for SSI is that the society at large has sufficient knowledge on radiation and its applications so that the detrimental effects on man, flora and fauna is minimised and that radiation protection activities are integrated in a comprehensive manner wherever relevant. The duties to be fulfilled according to the legal obligations are not entirely specific and some interpretation is necessary. Since there are also limitations on resources available to this kind of work, SSI has specified its main working goals and activity areas in strategic documents. The criteria used for making a judgement of a radiation protection issue are to make a balance or optimisation between the risk to public health, the risk to any individual person and the consequences of accidents. In this evaluation due consideration has to be taken concerning the consequences for the society, the cost effectiveness of counter measures and whether the problem will increase in future if no counter measures are taken. The main SSI strategic goals are expressed as the following:

- To prevent acute radiation damages and limit late effects of radiation
- To foresee and limit radiation problems in areas representing major values for the society
- To foresee and limit radiation problems in ecological systems

The working areas given priority by SSI the last five years and also for the next five-year period is targeted by the key words:

- Emergency preparedness against radiation accidents
- Nuclear power – normal operations
- Electric and magnetic fields
- Medical exposure of patients
- Radioactive waste
- Strong radiation sources
- Radiation in the environment
- Ultraviolet radiation

SSI has described a set of preferred methodologies in order to achieve its goals and to operate in the working areas given priority. What method or mixture of these to choose will differ between the areas. These methodologies are in short addressed as:

- Regulate, issue criteria and norms
- Make risk assessments concerning radiation sources, practices and consequences
- Make inspections and examinations
- Make own measurements, investigations and controls, test and examine radiation sources
- Control measurements made by others
- Perform research and develop
- Inform
- Perform environmental surveillance
- Educate and exercise the emergency preparedness organisation at SSI
- Teach
- Act internationally

To perform successfully within all these areas, SSI has recently begun an internal quality assessment of its own activities. This is a system under development and it is an instrument for the management of SSI but will involve the whole SSI organisation. The basic philosophy chosen is the total quality management where the basic criterion is that the quality is acceptable when the 'customer' is satisfied (The panel assumes that the 'customer' is well informed and that the satisfaction is long lasting).

Key elements for SSI to achieve correct quality within the SSI organisation are

1. **Priorities** – That SSI choose the right activities
2. **Competence** – The result has to be correct
3. **Organisation** – That SSI works according to best practice.

It is an expressed internal policy that SSI aims at a correct level of quality on their products and services – neither too high or too low. These key elements will be of importance also for the laboratory activities.

The panel finds no discrepancies between SSI's obligations and SSI's visions and priorities.

II.4 SSI's LABORATORY RESOURCES

A wide variety of laboratory functions and measurements can be considered necessary to fulfil all national and international obligations. The extent of such functions qualitatively and quantitatively is a question of balance and available resources. Priorities, competence and public confidence in the regulatory authority are important factors to be considered in such a judgement. The panel regards it as necessary for the regulatory authority to uphold its proficiency regarding radiation measurements and laboratory activities in order to be able to:

- Identify and assess qualitatively and quantitatively the relevant radionuclides and exposure from external radiation sources of relevance to existing and new radiation protection areas in the society.
- Make decisions in a nuclear emergency situation without being totally dependent on external laboratory expertise.
- Inspect and verify the radiation protection practices in the society.
- Act as national reference laboratory where the regulatory authority is the only option and participate in relevant national and international intercomparisons.
- Maintain and develop competence through research.

Outsourcing of certain laboratory activities is an option that the panel can suggest to be used in connection with:

- Routine measurements where methods are well established and when the research potential is minor.
- Continuous monitoring of normal environmental situations for emergency preparedness.
- Collecting data in routine environmental surveillance programs for assessment purposes.

However, even for routine measurements it can be a problem to find contractors who have the necessary resources and competence to fulfil all national and EU-obligations.

Radiochemistry laboratory, alpha + beta

This laboratory carries out a variety of radiation measurements, chemical procedures, sample preparations, specific radionuclide analysis as well as intra- and intercalibrations nationally and internationally. The work serves most of the preferred methodologies set by SSI as mentioned above.

Physically the laboratory consists of three rooms, two of which are 'laboratories' and the third a 15 m^2 counting room. One laboratory – called the 'Water-lab' – with an area of 30 m^2 is equipped with one fume cupboard. The second laboratory is 85 m^2 and partly divided in two parts with areas 60 m^2 and 25 m^2 respectively by a simple wall. Each part has 3 fume cupboards. In the water-lab chemical preparations and filtering are done on water samples from nuclear installations while subsequent gamma measurements on water and filters are done in the counting room. Analyses on Sr-90 and tritium in water samples take place in the second laboratory, in the 60 m^2 part that is mainly used for Sr-90 analysis with different types of environmental samples. The work here includes sample preparation, drying, evaporation, weighing and chemical procedures. The alpha analyses for Pu and U are done in the smaller 25 m^2 part of the second laboratory. Similar sample preparations are carried out here followed by chemical separation. The instruments available in this laboratory are:

Gamma measurements:	Two HPGe detectors located in the counting room
Beta measurements:	Liquid scintillation counter. Brandname Quantulus Wallac
Alpha measurements:	Four alpha detectors which can operate in parallel. Brandname Tennelec, Located in the counting room.

Three laboratory technicians work in this laboratory with ca. 1 man-year workload (not including data handling and administration associated with the laboratory activity). The laboratory is a key factor in environmental surveillance and monitoring projects and programs, including the coming implementation of EU's recommendation on the application of Article 36 concerning environmental monitoring. The laboratory plays a vital role in developing new types of samples and procedures concerning effluents to the environment. Research activities are done, often as pilot studies to investigate or test certain hypothesis or ideas as parts of more prolonged programs dedicated to environmental surveillance. Some measurements have been going on for many years. One example is Sr-90 measurements in milk from the sixties, which today represent a valuable radioecological database. The laboratory participates in international research projects related to radioecology in forests. To ensure a high level of quality in the measurements at own premises as well as in other similar Swedish laboratories systematic intercalibrations are done regularly nationally with laboratories in nuclear installations and internationally organised by WHO, IAEA, Helcom-Mors and NKS at the Nordic level.

The panel finds that the radiochemistry laboratory is important for SSI's activities concerning investigations, controls, environmental surveillance, research and development. The laboratory equipment seems sufficient for the purpose. It is the panel's opinion that a radiochemist should be attached to the laboratory and be responsible for its functions.

Radon laboratory
Internationally SSI pioneered research on the exposure to radon in homes and the assessment of doses from radon. Laboratory facilities for radon studies were built in the seventies with an area of 50 m^2 equipped with ventilated laboratory benches. The laboratory also has two radon-rooms equipped with reference instrumentation in the basement. A main activity has been calibration of radon detectors as well as development of measuring techniques. From this work different methodologies for radon measurements in dwellings have been developed and described. The laboratory functions as a national standard laboratory for radon measurements. The laboratory has been involved in large projects for mapping the radon concentrations in Swedish dwellings as well as epidemiological studies on radon. Simple measuring devices for radon are made available to schools teaching physics. This laboratory is also used to some extent for sample preparation related to gamma measurements in the gamma laboratory. The workload is totally 1.4 man-year with the major part in the area of research and inspection/surveillance.

The panel finds that the activities concerning standards, references and calibrations for radon measurements are important activities in relation to SSI's ability to make its own measurements and to inspect and control measurements made by other laboratories. The importance is underlined by the fact that the exposure to radon progeny in indoor air is the largest single contribution to the Swedish populations exposure to ionising radiation. It is the panel's opinion that the work concerning standards, references and calibrations should be placed at the 'Riksmätplats'. Continued development of retrospective radon dosimetry may be desirable and could also be a part of SSI supported research at external laboratories.

Non-ionising laboratory – Electromagnetic fields
SSI has a special group working with non-ionising radiation and this group has a laboratory room dedicated to measurement of electromagnetic fields. The room has an area of 43 m^2 and is screened to eliminate electromagnetic fields form outside sources. In the room is situated a so-called 'Crawford-cell' where it is possible to set up well defined electromagnetic fields. With this equipment stability tests of measuring instruments are done as well as calibrations. The group works with environmental surveillance and inspections, advanced research as well as investigations of provocative material. Measurements are also done in co-operation with other authorities with respect to control of products or market control. The workload in this laboratory is estimated to 0.4 man-year with research as the dominant activity.

Radiation protection issues related to electromagnetic fields is one of eight areas given priority by SSI. The risks associated with electromagnetic fields are at present far from being understood and SSI should continue to contribute to the research both through funding and by SSI's own research projects. Hence, the panel finds that laboratory facilities at the present level should be planned also for the coming years. The number of inspections and testing may increase in the future. In that case, outsourcing of the routine work should be considered.

Non-ionising laboratory – Optics
Another area of priority for SSI is radiation protection related to ultraviolet radiation. For this purpose the non-ionising group has a well equipped optical laboratory. This laboratory is 43 m^2 and is black painted with dull finish to reduce problems with stray-light and reflexes during measurements. In addition the group has an outdoor measuring platform on the roof of house Z6 with a small adjacent room for storage and service purposes. The optical laboratory is equipped with specialised optical sources, optical detectors and instruments. The type of work in this laboratory is similar to the type of activity performed with electromagnetic fields. The workload is estimated to 0.8 man-year with the dominant contribution related to environmental surveillance of solar ultraviolet radiation.

Since ultraviolet radiation is well documented as being a key factor causing skin cancers in the population, continued work on ultraviolet radiation is considered to be good radiation protection and cost effective. The panel finds that SSI's measurement capacity will be necessary also in future in this area, and specialised laboratory facilities and instruments have to be foreseen. One specific function, the inspection of solarium UV facilities may be considered for outsourcing, if this activity increases in the future.

X-ray medical diagnostic laboratory

The historical roots of radiation protection are connected to X-rays especially in the medical applications of X-rays. On this background it was natural that national radiation protection inspection bodies or authorities had X-ray laboratories for doing radiation measurements, tests and research. This was the case for SSI and similar to the situation in many other countries. Vital results with relevance to radiation protection were achieved in such X-ray laboratories.

At present SSI still has such a laboratory with an area of 20 m^2. It is equipped with typical medical X-ray equipment with fluoroscopic image intensifier. It is used for testing of measuring instruments, phantom measurements, sensitivity measurements of X-ray detector systems etc. The workload in this laboratory is minor, only 0,1 man-year. In connection with the introduction of reference levels some measurements are planned for the coming year provided the X-ray equipment still would be operable. No plan exists for renewal of X-ray equipment at SSI. The golden time for such X-ray laboratories in institutions such as SSI seems to have passed away. Today, there is a large commercial market for measuring instruments with many options and suppliers. In addition medical X-ray equipment is produced according to international standards. Nevertheless, measurements and radiation protection measures still have to be done but the panel finds that it will be more relevant to do measurements based on contracts or agreements in medical establishments using relevant X-rays apparatus.

Gamma – laboratory

This laboratory is equipped with two HPGe detectors and is located in the low-background radiation Whole body laboratory of the SSI. This makes the laboratory especially suitable for low-activity gamma measurements. The laboratory has emphasised its ability to make accurate measurements of selected radio nuclides and has thereby served as an unofficial reference lab in Sweden for measurement of activity concentrations of cesium in milk, radium, thorium and potassium in building materials, radon in drinking water and radon in air at high concentrations. To be able to make accurate measurements a QA programme is followed and a Quality control programme is maintained mainly by taking part in intercomparisons organised by internationally recognised organisations. The laboratory has also been used for fast response determinations of unknown radio nuclides in accident situations. The laboratory has been used for investigation projects of the radiological impact of certain practices, which occasionally has resulted in recommendations and legal documents to minimise the dose consequences. Lastly the laboratory has been used in connection with several research projects. The total workload related to gamma-measurements is estimated to 1,25 man-year with inspection related work as the dominant part and quality assurance as the second main activity. The panel finds that the functions of this laboratory at it's present level are indispensable for SSI for inspections, tests of radiation sources, control of other laboratories and for research and development.

Whole body laboratory

The laboratory was planned in the historical period with the threat of nuclear war. It was built in the early sixties, located at the basement level in SSI's present building with an area of 50 m^2. The laboratory is specially designed, built and equipped to be a dedicated room with low background radiation suitable for whole body or partial body counting. There are adjacent service rooms for the laboratory with a total area of 116 m^2. The scintillation detectors used are old but still in operation. The laboratory holds a high international standard with very low and stable background radiation.

The present workload is estimated to 560 working hours or approximately 0,3 working year. The laboratory functions are predominantly in the fields of emergency preparedness, environmental surveillance and research. A small fraction of the work is used for inspection activities, quality assurance and ‘others’.

The laboratory play an important and vital role as a national reference and calibration laboratory for other licensed practices such as nuclear power plants and nuclear fuel facilities where whole-body measurements is a prescribed obligation. Even in the Nordic perspective the SSI whole-body laboratory is a key partner to maintain and develop comparable functions in these countries.

Internationally there is an increasing interest to document internal exposures especially for workers and in the European union efforts have been taken to harmonise in this respect. SSI is working on national guidelines to implement Article 25, section 1 of the BSS Directive regarding monitoring of internal contamination.

The panel finds that a capability for whole body measurements is vital for SSI’s work with criteria's and norms and for SSI’s inspections and research. The present installation is unique due to it's low background. If SSI should move to new premises, a similar new construction would probably be very expensive. It is the opinion of the panel that less could do, and that a facility for whole body measurements should continue to be a part of SSI’s laboratory facilities.

Field-gamma/GIS laboratory

This is a rather new activity at SSI that started 1988 based on experience and needs developed after the Chernobyl accident. This activity is a new type of laboratory; it consists mainly of detectors, computers, printers, communication technology, and mobile platforms to carry on helicopters, cars or as backpacks. A vital element in the system is the coupling to the geographical information system, GIS. The main GIS function is to collect, store, update, process, analyse, and present geographically related data. The results obtained from the system is principally geographical information or maps with dose rates and/or with specification of different radionuclides of interest. The development and maintenance of GIS functions is organised at SSI in the section for information technology. Furthermore the GIS group works with the access to other national relevant databases from the National Land Survey of Sweden (LMV), Statistics Sweden (SCB) and the Geological Survey of Sweden (SGU).

The main purpose of the system is twofold, to act in the emergency preparedness system against nuclear accident and secondly to be used in environmental surveillance programs concerning radionuclides.

The equipment used at present consists of two complete HPGe detector systems for in situ measurements or mobile measurements, two complete NaI detector systems for mobile measurements, and one NaI detector system for in-situ measurements. There are several computers available as well as dedicated software. For helicopter measurements special equipment is available. In addition some hand instruments for dose rate measurements are available.

The staff involved for the field gamma measurements is 3-4 highly competent persons, all physicists/geophysicists. The activity has no need for specialised rooms or areas, apart from workshop facilities and some storage facilities for equipment. In total the workload is of the order of 1 man-year.

The opinion of the panel is that this activity is highly cost-effective and fulfils vital needs in modern radiation protection for the competent authority and it is recommended to continue and further develop this activity.

III. The system of contract laboratories for radiation protection emergencies.

III.1 OVERVIEW

The Swedish government has given SSI the obligation of '*maintaining and developing a co-ordinated national radiation protection emergency preparedness*'. This is interpreted as activities to assess and mitigate the consequences arising from radioactive fallout or any other emergency situation involving risks from radiation, as defined in the Emergency Services Act (1986:1107, 46c§). The radioactive fallout could originate from a nuclear detonation or from unplanned releases from a nuclear facility.

In order to fulfil this task SSI maintains a system of contract laboratories (CL's). A typical CL is a university department doing research in the field, and often connected to the radiation physics department of a hospital. The CL's are required to maintain their equipment operable and to have available personnel capable of using it. If an emergency arises the CL's must at short notice be able to make measurements specified in the contracts. The CL's are compensated annually to maintain this readiness and for the participation in intercalibration exercises and meetings of all CL's. SSI has also provided funds for acquiring equipment when necessary.

The CL's have (with certain exceptions) not been required to do any routine work. If an emergency should make it necessary for SSI to demand the services of a CL for longer than three days, the CL will be recompensed for this.

The nuclear power plants (NPP's) in Sweden also have an obligation to participate in measurements of anthropogenic radioactivity in an emergency situation, but are not recompensed for maintaining emergency preparedness.

The major task of the evaluation panel was to make recommendations on which of SSI's laboratory activities could be outsourced and which activities SSI ought to retain. As a part of this task a survey of the possible external laboratories had to be made. The contracts with the current CL's and NPP's were made available to the panel. Members of the panel visited five CL's. SSI sent a questionnaire to 13 CL's and 4 NPP's, asking them to describe their professional profile, available equipment and personnel.

III.2 THE CONTRACT LABORATORIES

The contract laboratories are listed in Table 3-1. The code numbers (CL n:o) will be used below to refer to the laboratories.

Figure 3-1 (see page 16) shows where the CL's are located. In February 2001 SSI sent a letter to the seventeen laboratories listed in Table 3-1, requesting them to describe their professional profile, i.e. their material and human resources related to the laboratory activities in question. The letter specified the following areas of interest:

- Measurement of ionising radiation (alpha, beta and gamma analysis)
- Whole-body counting
- Radon
- Radiochemistry
- X-rays
- Measuring gamma radiation in situ and with mobile equipment
- Non-ionising radiation

Table 3-1. The contract laboratories included in the survey.

CL n:o	Laboratory
1	Avdelningen för radiofysik, Gula stråket 4, Sahlgrenska universitetssjukhuset SE-413 45 GÖTEBORG
2	Avdelningen för radiofysik, Institutionen för medicin och vård Hälsouniversitetet, Linköpings universitet SE-581 85 LINKÖPING
3	Avdelningen för radiofysik, Jubileumsinstitutionen, Lunds universitet Universitetssjukhuset SE-221 85 LUND
4	Institutionen för radiologi och fysiologi, Avdelningen för radiofysik Lunds universitet, Universitetssjukhuset MAS SE-205 02 MALMÖ
5	Medicinsk strålningsfysik, Institutionen för onkologi-patologi Karolinska institutet, Box 260 SE-171 76 STOCKHOLM
6	Institutionen för strålningsvetenskaper, radiofysik, Umeå universitet, Universitetssjukhuset SE-901 85 UMEÅ
7	Studsvik Nuclear AB SE-611 82 NYKÖPING
8	Totalförsvarets forskningsinstitut (FOI), Enköpingsvägen 126 SE-172 90 STOCKHOLM
9	Avdelningen för NBC-skydd, Totalförsvarets forskningsinstitut (FOI) SE-901 82 UMEÅ
10	Sveriges Geologiska Undersökning, Box 670 SE-751 28 UPPSALA
11	Sveriges Lantbruksuniversitet, SLU, Institutionen för Markvetenskap, Box 7014 SE-750 07 UPPSALA
12	Sveriges Lantbruksuniversitet, SLU, Institutionen för jordbrukets biosystem och teknologi (JBT), Avd för djurmiljö och byggnadsfunktion, Box 59 SE-230 53 ALNARP
13	MALÅ GeoScience AB, Skolgatan11 SE-930 70 MALÅ
14	Barsebäck Kraft AB, Box 524 SE-246 25 LÖDDEKÖPINGE
15	Forsmarks Kraftgrupp AB SE-742 03 ÖSTHAMMAR
16	OKG AB SE-572 83 OSKARSHAMN
17	Ringhals AB SE-430 22 VÄRÖBACKA

Two laboratories (numbers 12 and 13) replied that they do not have any laboratory activities at all in the areas of interest. One of the NPP's (OKG, n:o 16) stated that no resources are or will be available for external customers. These sites are excluded from the discussion in this chapter. One laboratory (n:o 3) did not reply at all, but a consultant visited it. Some data are from document 33, appendix C.

Non-ionising radiation: Only two of the contract laboratories have resources in this area. In Göteborg (1) there is a laboratory for NIR with capability of spectral analysis and simple intensity measurements in the IR to UV range, and instruments for measuring electrical and magnetic fields. The Malmö institution (4) has a gaussmeter, an instrument for measuring low-frequency magnetic fields and an instrument for measuring microwaves.

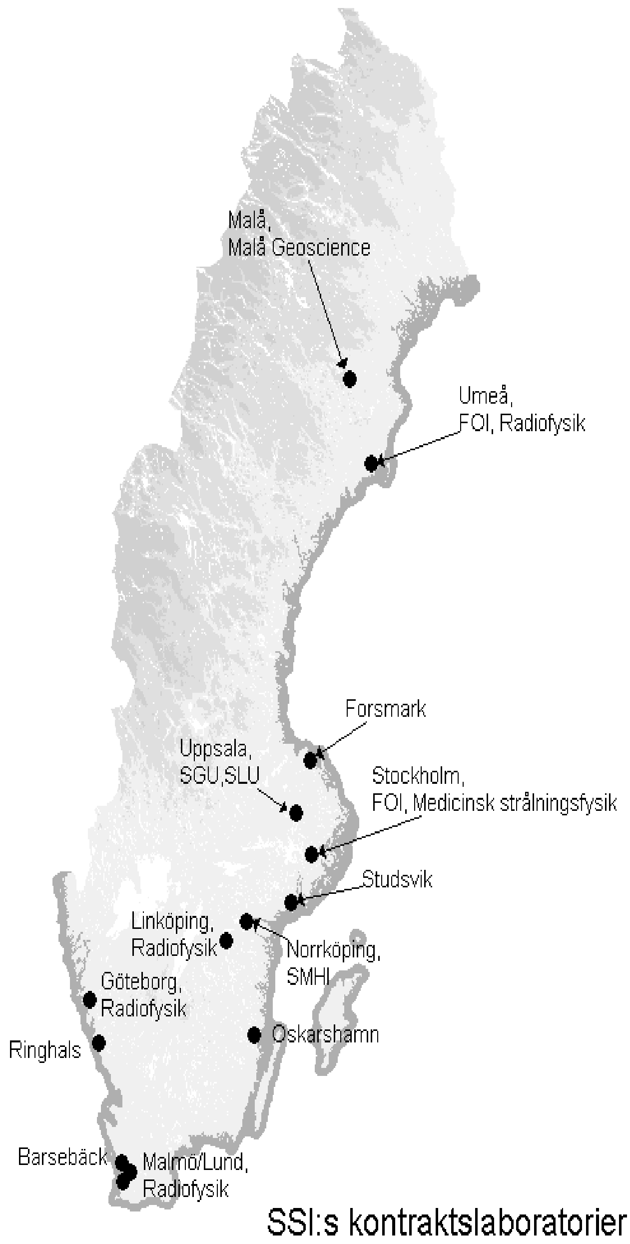


Figure 3-1. The contract laboratories

X-rays: The heading is taken to mean dosimetry in the medical use of X-rays. Laboratories 1, 3 and 8 report having X-ray generators, although all the hospitals associated with laboratories 1 to 6 naturally have medical X-ray equipment available. Laboratory 6 reports an ongoing project to survey patient doses from CT scans.

Radon: Most of the respondents have no activity in this area. Laboratories 2, 3, 4, 9, 10 and 14 say they can measure radon in water, and laboratory 8 has calibrated bottle geometries for radon daughters. Laboratory 10 has an Emanometer, Marcus 10.
Laboratory 3 has a pulse-ion chamber for retrospective dosimetry, track etch facilities, two Atmos continuous Rn monitors and share a radon chamber with the Technical University of Lund.
The CL in Göteborg (n:o 1) has a radon room and facilities for track film and filter measurements. The detectors are calibrated at SSI and the laboratory has taken part in intercalibration exercises arranged by the NRPB. The facility is used mainly for educational purposes.

Whole-body counting (WBC): The contracts for laboratories 1, 2, 3, 4, 6 and 8 all require the CL to ‘perform whole-body counting with stationary equipment, and with mobile or portable equipment if available’. Laboratory n:o 9 is required to measure ‘a few persons daily’, including a measurement of iodine isotopes in the thyroid.
All the NPP’s (14-17) have whole-body counting facilities suitable for their own requirements. It would probably not be feasible to use these counters for monitoring persons not employed by the NPP’s, and the agreements between SSI and the NPP’s regarding emergency preparedness do not mention whole-body counting at all.
Table 3-2 lists the whole-body counter facilities covered by the survey. Apart from these facilities ABB-Atom AB in Västerås has a facility for measuring low-energy X-ray emitters in the lungs.

Table 3-2. Whole-body counting facilities.

CL n:o	Background shielding	Measuring geometry	Detectors	Mobility
1	Concrete + steel room	Scanning bed	2 NaI 5" x 4" + 1 HPGe + NaI for thyroid	No
	Concrete + steel room	Bed	Plastic scintillators	
3			NaI 8" x 4"	No
4	Steel room	Scanning bed	2 NaI 127mm x 102mm	No
5	Hoforsite room + partial lead shielding	Chair	1 HPGe	No
7	Steel room + lead	Chair	1 HPGe, 50% + NaI for thyroid	No
	Collimators only	ISOCS system	Broad-energy detector	Yes
9	Lead shadow-shield	Modified chair	1 HPGe, 50%	Mounted in trailer
14	Steel room	Chair	1 HPGe, 55%	No
15	'Low Background Counter 1046'		1 HPGe 1 NaI for thyroid	No
17	Shielded cage		HPGe 35%	No
	Quick-Scan portal, MDA 300 Bq/detector unit			

Radiochemistry: The facilities and expertise for radiochemical analyses vary greatly. Table 3-3 lists the answers to the survey.

Table 3-3. Radiochemistry.

CL n:o	Premises	Analyses performed
1	One room for sample preparation, one radiochemical laboratory	^{99}Tc, ^{90}Sr, ^{3}H, ^{14}C ^{239,240}Pu, ^{241}Am etc.
2		^{210}Po in water, sediment and biota Pu isotopes in water, sediment and biota Separation and concentration of Cs in water
3	One room for radiochemistry	^{90}Sr, U, and transuranium analysis
4		Sample preparation for ^{14}C determination
7		^{90}Sr, U, and transuranium analysis
8	New premises: 2·30 x m^2 for radio-chemistry, 15 m^2 clean room for ICP-MS, sample preparation room	^{90}Sr, U, Pu and Am in 'radioecological' sample matrices. The high-resolution ICP-MS will give additional capability.
9	A comprehensive radiochemical laboratory, dedicated space for environmental analyses	Sample treatment for α analyses (transuranics), ^{90}Sr, environmental analyses. Under development: ^{55}Fe, ^{63}Ni.
17		Routine analyses of ^{90}Sr and transuranics

Measurement of α, β and γ radiation: Table 3-4 lists the resources of the CL's for measuring radiation. Ordinary health physics instruments are not included. LSC = liquid scintillation counter. The pulse height analysers are not listed but usually there is one for each detector.

Table 3-4. Instruments for radiation measurement.

CL n:o	Instruments for α radiation	Instruments for β radiation	Instruments for γ radiation
1	3 detectors in use (3 extra chambers available)	1 LSC (+1 not in use)	3 NaI detectors 4 semiconductors
2	5 PIPS detectors, 1 LSC	1 LSC, Wallac 1415	2 HPGe (10% and 42%) 1 NaI in lead cave 1 portable NaI
3	23 spectrometers 2 ion chambers	14 GM counters 1 ion-implanted Si	6 HPGe (9 – 47%) 1 Si(Li) 2 NaI (one sample changer) 2 mobile NaI
4	1 LSC, Wallac 1217	1 LSC, Wallac 1217	2 HPGe (36%, 5%) 1 portable NaI 'Nomad' Future: 1 HPGe, 16%
5			1 HPGe
6			2 HPGe + 1 portable HPGe
7			6 HPGe (20 – 80%) 3 portable HPGe
8	Octête, 6 Si-detectors and 2 external chambers 1 proportional counter Quantulus 1220 LSC Field monitors (gross α)	Quantulus 1220 LSC One 'older' LSC	2 HPGe (55% and 80%) 2 portable HPGe (36% and 50%, also used for WBC) 1 LOAX HPGe (for low gamma energies)
9	12 vacuum chambers 4 detectors in the hot cell lab. 2 detectors for gross α	3 detectors for gross ß 1 LSC, Wallac 1219	3 semiconductors, 30% 1 ISOCS system for in situ measurements and WBC
10			1 semiconductor 10 portable gamma-spectrometers (survey instruments) 1 system for aerial surveys with 2 NaI detectors (16.7 and 4.2 litres)
11		1 Risø GM 25-5 1 LSC Packard	5 HPGe 1 NaI
14	Octête with 8 chambers under installation	1 LSC Wallac Winspectral	6 HPGe (5 – 25%)
15	4 α spectrometers 3 detectors for gross α	2 LSCs	5 stationary Ge 2 Ge for in situ + 1 for exemption measurements
17	8 detectors	3 LSCs	17 semiconductors + 2 for in situ

III.3 CONTRACTUAL DUTIES

The contracts between SSI and the different CL's are almost identical in structure. The first chapter defines the legal basis for the activity. The second chapter defines the duties of the CL under the contract.

The CL shall start the measurements set down in an appendix to the contract 'within a few days'. Each CL is primarily responsible within own and adjacent counties. The CL is responsible for having qualified personnel available and the equipment in working order and calibrated. Computer software delivered by SSI shall be installed without delay. In an emergency situation measurements shall be performed according to instructions from SSI, and the results shall be transmitted immediately upon completion by electronic means, and within 3 days in writing. The CL shall maintain an emergency plan and a call-up list of its personnel. The personnel of the CL shall be adequately trained and must participate in national exercises, meetings or training arranged by SSI or other authorities. The CL shall participate in intercalibration exercises, both on its own initiative and if requested by SSI. The concluding paragraph deals with renewal and termination of the contract, and states the annual compensation for the services of the CL.

The appendix to the contract lists the specific duties required in an emergency situation. Typical duties are listed below. The specification is tailored to the capabilities and expertise of each CL by making a selection from the list.

- Make instruments and a health physicist available for aerial measurements in a helicopter from the armed forces. The specialist performing the measurements is also responsible for the radiation safety of the helicopter crew.
- Measure the activity of samples of grass (cattle fodder). Voluntary workers will collect the samples and possibly also assist with their handling. The primary radionuclides to be determined are ^{131}I, ^{134}Cs and ^{137}Cs. The CL must be able to measure (10 – 50) samples per diem.
- Take and measure daily samples of milk from (a few) farms. There is a national register of farms from which samples are to be taken.
- Take and measure samples of grass and milk from a farm selected in advance.
- Perform mobile gamma spectrometry with a NaI(Tl) detector, GPS navigator and dose rate meter if the equipment is available. The task may include searching for radiation sources. Later HPGe detectors may be substituted for the scintillation crystals.
- Perform high-resolution gamma spectroscopy in the field to determine radioactivity on and in the soil. Measure the dose rate with a separate instrument. Take soil samples and determine the activity profile in the soil and the water content.
- Assist in taking air samples with filter equipment belonging to the Defence Research Agency (FOI), SSI or the regional emergency service. Measure the activities in particle or carbon filters with high-resolution gamma spectroscopy. Make direct determinations of alpha emitters on membrane filters. Special attention is to be paid to rapid analysis of filters from the vicinity of NPP's.
- Take samples of soil, water, the biosphere etc., prepare the samples and perform high-resolution gamma spectroscopy.
- Perform radiochemical analyses with alpha and beta spectrometry on environmental samples and air filters. If possible, develop the fission track analysis method for determination of low plutonium concentrations in biological samples.
- Perform mobile dose rate measurements, including searching for radioactive sources.
- Measure alpha and beta radiation with hand-held instruments.
- Perform emergency dosimetry based on ESR (Electron Spin Resonance) spectrometry.
- Assist in measuring surface contamination on people. If necessary (and jointly with SSI), advise regional authorities and the medical services on decontamination of people.
- Measure internal contamination with stationary, mobile or portable whole-body counting equipment, as available.

- If requested by SSI, provide expert advice to regional authorities on reporting and interpreting results of radiation measurements. If necessary, explain actions, advice and recommendations of SSI.

III.4 VISITS TO THE CONTRACT LABORATORIES, DISCUSSION

The panel members visited five contract laboratories: Lund (3), Studsvik (7), the two units of FOI (8 and 9) and Umeå (6). These visits and the data presented above form the basis for the opinions expressed below. The contract laboratories fall into several categories: the university institutions (1 to 6 and 11), the nuclear power plants (14 to 17) and commercial enterprises (only one was included in the survey, n:o 7, but others could have been investigated). Finally there are laboratories of other state authorities (8, 9 and 10), which really are unique cases within the CL system and will be discussed separately.

The **university institutions** have strong ties to the medical profession – with one exception, n:o 11. They all have been engaged in radiation-related research, and some still are. It seems, however, that the scientific interest is shifting away from radioecology and other subjects within SSI's domain. Young scientists do not choose radiation protection or radioecology for their research – one reason being the scarcity of research funding for these disciplines. Recruitment of persons to replace the scientists reaching retirement is becoming a problem for the CL's in this group.

In many of the university CL's the contact person is the only one actively engaged with the tasks in the contract with SSI. He or she has to engage colleagues when needed, for example when an intercalibration exercise is being run. Emergency call-up lists are probably out of date in many instances. It is suggested that the next contracts should include the possibility of emergency exercises without previous warning, and that surprise exercises should be carried out. The panel finds that the emergency preparedness system could benefit from a concentration on fewer and larger contract laboratories and that the smaller laboratories instead should be supported by research contracts.

The possibility of SSI outsourcing routine activities to contract laboratories was naturally discussed with representatives of the CL's. The response was negative in most cases. Although university institutions do perform contract research, it is usually only for limited periods of time. Moreover the research must have a scientific interest for the institution, must fit in with its educational activities and should produce publications. Routine laboratory measurements do not fill these requirements, and universities cannot guarantee the necessary continuity. An extreme case is the Swedish University of Agricultural Sciences (SLU) where the Department of Radioecology was closed down in 1998/99, the professorship discontinued and part of the research moved to the division of Soil Chemistry and Pedology at the department of Soil Sciences (CL number 11).

The **nuclear power utilities** also reacted negatively to the proposal of taking over laboratory activities from SSI. One of them (OKG, n:o 16) explicitly stated that its resources are for internal use only. The other utilities also stressed that their resources were dimensioned according to internal needs. Furthermore — as a matter of principle — the NPP's should not be given the task of monitoring activities of their own.

The **commercial enterprise** Studsvik Nuclear AB (n:o 7) has considerable resources in nuclear technology, about 180 employees and more than adequate premises and equipment. Studsvik's obligations as a contract laboratory are clearly integrated into its routine work and internal emergency preparedness system, which of course helps to ensure a fast and efficient response to a national emergency situation. The compensation under the contract is not very high, but Studsvik still considers the contract very important as a token of their competence and as a channel of information. Studsvik could very well imagine a SSI without any laboratory resources of its own, and is obviously interested in a larger contract with SSI.

The **Geological Survey of Sweden** (SGU, CL number 10) is a national authority responsible for questions relating to Sweden's geological character and handling of minerals. SGU does aerial surveys of ionising radiation for SSI (e.g. the Chernobyl fallout map). SSI partly financed the equipment for this purpose. It is improbable that SGU could take on any other laboratory activities currently run by SSI.

The **Swedish Defence Research Agency** (FOI, formerly FOA) has many interests in common with SSI. FOI has for several decades been active in research related to nuclear weapon issues. Based on core knowledge in nuclear physics and nuclear weapons FOI has developed high competence in threat analysis, effects, protection and detection. It has developed services and expertise in nuclear arms control, disarmament, non-proliferation, export control and verification. The customers are national authorities as well as international organisations. Two of FOI's units, Stockholm and Umeå, have contracts with SSI.

The FOI unit in Stockholm (n:o 8) has a unique position among the CL's, since the contract specifies ongoing tasks in addition to those that will come into force after an alarm. FOI continuously collects samples of airborne activity at five stations, and collects samples of gaseous iodine on carbon filters at four stations. The contract with SSI naturally is more expensive than those with other CL's. The interviews with the staff at FOI and the documents made available can be summarised as follows:

- The air sampling and monitoring serves important goals for SSI as well as for other customers such as the Swedish defence ministry, Swedish foreign ministry and Swedish environmental ministry. Thus, this activity in an example of very good synergy between different national goals. When combining this in such a manner it is possible to maintain and develop high and dedicated competence with sufficient resources that is of high importance for all.
- The economy in the contract, which is approximately 10 % of the annual budget for total activity in this sector at FOI, is considered to be fair and at an adequate level.
- The competence for this work at FOI is excellent and so is also the age distribution of the involved staff. Through new recruitments in recent years FOI has managed to change the staff age distribution from rather 'old' in 1997 to 'young/middle aged' in 2001. This should be considered to be prosperous for future development and continuity.
- The internal work in FOI for QA seems sufficient and well functioning. Concerning the need for accreditation for this service the consultant group do not consider accreditation to be cost-effective in this case.
- The work initiated to develop an intranet between the air sampling stations is to be encouraged and in future SSI could consider taking part in this intranet and including this in the contract. This will probably increase the value of the monitoring with respect to the early warning aspect of the emergency preparedness for SSI and make the reporting more efficient.
- FOI has over time developed an informal network between other similar air sampling stations in Europe with the purpose to exchange data on occasional concentrations of man-made radionuclides in the atmosphere – the so-called Ring of Five. The network contributes very efficiently to the early warning dimension for the participants and is an example of good, practical European co-operation. It is quick, efficient, un-bureaucratic and very cost-effective.
- It is unlikely that FOI Stockholm could take over any other laboratory activities currently performed by SSI.

The FOI unit in Umeå (n:o 9) also is a very important partner in co-operation with SSI. Apart from the contract SSI also has arranged finance for several research projects carried out by FOI.

The personnel engaged in the relevant activities are qualified and the age structure is excellent. FOI seems not to have the problems of recruitment when compared to the university institutions. The material resources also are more than adequate, with considerable improvements already authorised. FOI Umeå certainly could take on more tasks from SSI, even routine measurements. Doing so would probably strengthen FOI's capabilities. Being a non-profit official body FOI could even do it at cost. However, the opinion of the researchers at FOI was very much against such a development. It was felt that SSI without laboratories of its own would be a toothless and less creditable authority. SSI's professional ability to contract outside services would also decline.

IV. General considerations on outsourcing

The field of radiation protection has always been closely linked to and associated with the capability and necessity to measure the radiation. In addition to the evolution of instrumentation for the purpose, the definition of suitable quantities to characterise and quantify the radiation has also been extremely important in order to manage both the acute and the long-term risks. A proper national system of radiation protection consists of the following main elements:

- Legislative and regulatory instruments and resources.
- Adequate competence related to scientific and technical radiation protection.
- Adequate resources for inspection, surveillance, monitoring, assessments and verification of radiation protection in practices and intervention situations.

The laboratory and measurement functions involved under the third bullet may be carried out by the regulatory authority's own laboratories, or the activities may be outsourced to research laboratories or private enterprises. In fact significant differences exists even between the Nordic countries as to the way this is organised (appendix B).

Due to the special nature of radiation protection, decisions on outsourcing of laboratory and measurement functions in this field should take into account questions like the public confidence in the regulatory authority, possible conflicts of interests, availability of the services, quality assurance and quality control, and questions on continuity and vulnerability.

IV.1 THE SPECIAL NATURE OF RADIATION PROTECTION

In the early years of radiation protection, focus was towards measures to protect against acute effects of radiation, but in the middle of the 19-fifties the long-term stochastic effects of radiation became a new challenge for radiation protection. The lack of perceptibility of ionising radiation by our natural sense organs was a challenge, which has led to a large variability and complexity of measuring systems. With time, a sophisticated system of radiation protection has been developed through international co-operation. The result is that radiation protection has developed from a system mainly consisting of measurements and technical protective measures, to a system of long term risk management where the measurement is one of several key elements in the protection. However, measurements still play an important and vital role - not only for verification purposes but also for building confidence in public relations.

In the process of development of radiation protection, Sweden, with its authorities and scientific resources, have in the whole period played a key role with long traditions and outstanding records.

In most countries, the use of radiation sources and radiation protection is regulated by special legislation and specialised authorities are dedicated to this task. Within the European Union, it is a requirement from the European Commission that member states shall have competent authorities in the field of radiation protection. The relevant directives (Council Directive 96/29 Euratom and Council Directive 97/43 Euratom) describe several objectives that have to be fulfilled and which imply directly or indirectly measuring activities. However, the directives do not in detail describe the national organisation of such measuring activities or quantitatively the content of such activities.

IV.2 PUBLIC PERCEPTION OF AND CONFIDENCE IN SSI

It is a necessity for SSI's work to have the confidence of the public at large. This is a general condition for any governmental authority, but even more so for SSI, whose mission is to protect radiation workers and the general public as well as the environment from the harmful effects of radiation, which requires specialised competence and equipment to be detected. This condition of public confidence is also reflected in the way SSI communicates with[GS4] the public in various publications and on the Internet.

SSI fully enjoys this confidence. This is evident from the panel's discussions with SSI's contract laboratories. It is supported by SSI's excellent internationally recognised research work and contributions to the international co-operation on radiation protection issues. This confidence in SSI's proficiency concerning methods and instruments is important at several levels of SSI's work with nuclear emergency preparedness and the different functions as the regulatory authority.

In the nuclear emergency preparedness system SSI co-operates with the contract laboratories in defining terms and conditions for building and maintaining an adequate system of preparedness. In this work, SSI acts, and should act, as an equal partner when the extent of work and quality of instruments, software, and methods for the emergency management are discussed. In an actual nuclear emergency situation the responsibility rests with the Governor ([MT5]Landshövding) in the affected districts and SSI has the advisory and co-ordinating role concerning monitoring and intervention measures. Evidently, the profound public confidence in SSI's ability to effectively co-ordinate the national resources in that case is a crucial factor which, in the opinion of the panel, must be given high priority also in the future.

SSI is the regulatory authority vis-à-vis the nuclear power plants (NPP) concerning radiation protection of the employees and environmental monitoring, SSI inspects[GS6] the instruments and procedures used by the NPP's in these functions and engages the NPP's in various intercalibrations and other quality control measures. SSI's success in that co-operation rests on SSI's proficiency and experience with the instruments and methods in question. Similar considerations are valid concerning other practices with radiophysical installations.

As the regulatory authority SSI acts to confront new and sometimes controversial issues on radiation protection. In cases where measurements and methods are important, like the recent discussion on depleted uranium, the confidence in SSI's evaluations is supported by SSI's ability to make its own judgement independent of external laboratories.

As the regulatory authority SSI also contributes to the legislative procedures concerning radiation protection issues both nationally and in an EU context. When this work concerns regulations involving measurements and laboratory activities, the influence of the participants often depends on their laboratory- and measurement experiences.

It is the opinion of the panel that SSI's laboratory and measurement expertise within key areas plays an essential role for the public confidence in SSI and as a highly respected radiation protection partner in the EU collaboration. The regulatory authority must be able to express its opinion concerning radiation protection issues and measurement techniques and results based on first hand expertise.

IV.3 CONFLICTS OF INTERESTS

In a nuclear emergency situation the contract laboratories are obliged to supply laboratory capacity and measurements according to the individual contracts. As far as the NPP's are concerned the contracts are actually agreements to supply SSI with resources on a voluntary basis. Any conflict between wishes from the outside and the NPP's own emergency preparedness systems are thereby avoided. Studsvik Nuclear AB has a regular contract with SSI although Studsvik is in a position similar to that of the NPP's, having an internal emergency preparedness system related to its nuclear facilities. In this case a conflict between the outside wishes and the internal emergency preparedness system is not clearly addressed in the contract. However, one must assume that the local emergency system always has first priority.

Outsourcing of laboratory activities and measurements concerning the regulatory work of SSI presents a different picture. One type of laboratory work and measurements, the response to new challenges, will most likely involve sample preparation, radiochemical work and radiation spectroscopy. Examples could be public concern over radioactivity in products and in the environment or anxiety over new radiation related activities. A fast reaction may be important for SSI and an external laboratory may have other urgent tasks or interests. Such conflicts of interests should be dealt with in the contract but the possibility of conflicting interests remains.

A similar situation concerns laboratory and measurement work connected to regulation and inspection. SSI evaluates, and may in some cases stop risky practices. This kind of regulation may require laboratory and measurement work to support the decisions. The work could be outsourced in many cases, particularly when samples and measurements can be anonymised. However, this is not always possible or practical and if the work is left entirely to external laboratories, it becomes extremely important to ensure that the contracting laboratory is completely independent of the enterprises in question. The evaluation panel finds it important that SSI retains basic laboratory and measurement facilities in the key areas in order to be able to make its own independent investigations.

IV.4 AVAILABILITY

The availability of an external laboratory service has to be considered for three scenarios: national emergencies, radiation incidents, and routine measurements.

SSI has set up the present system of contract laboratories to deal with national emergencies involving risks from radiation. The CL's are required to respond to an alarm from SSI 'within a few days'. To demand a higher degree of readiness would mean much more expensive contracts. In the initial period of an emergency SSI, FOI and the nuclear power plants would cover the immediate need for laboratory resources. If SSI were to dispense with its own laboratory resources an alternative would have to be found to deal with the immediate response.

A radiation incident, which is neither routine nor a national emergency, might be a local contamination, loss of a radiation source, a transport accident involving radionuclides, an equipment malfunction or an infringement of operating rules. Real risk of radiation can arise out of an incident, but it can also be a media canard involving no actual risks. Most incidents are unexpected, since once a certain incident has occurred steps will be taken to prevent its recurrence. After an incident – real or imagined – SSI must, as the competent authority for Sweden, respond without undue delay. SSI must decide on the appropriate action and usually also inform the public. In most cases the decision rests on measurements, i.e. laboratory resources. Problems may arise if SSI has no laboratory resources of its own. It may be necessary to have under contract an action team, ready to follow the inspectors of SSI to the site of the incident within hours of an alarm.

The panel foresees problems if SSI has to rely entirely on external laboratory services in responding to radiation incidents or nation-wide emergencies. The cost of having an external measuring team ready for deployment at short notice may well be prohibitive. SSI's ability to co-ordinate the efforts of other authorities and the contract laboratories will be undermined if the institute's personnel do not have the professional ability to make state-of-the-art radiation measurements. This ability will inevitably decline if SSI dispenses with all its laboratories.

In the case of routine measurements availability is contracted for and paid for. The degree of availability can easily be optimised.

IV.5 QUALITY ASSURANCE, QUALITY CONTROL, STANDARDS AND REFERENCES

SSI does not at present demand that the contract laboratories have formal accreditation of their measuring procedures. The current system of regular intercalibration exercises is adequate, but without laboratories of its own SSI could not supervise the intercalibrations efficiently. In such a situation SSI would probably have to require accreditation from the external laboratories. In order to be accredited a laboratory must be able to demonstrate traceability to reliable references for the quantities it measures. SSI provides the primary national references for absorbed dose, kerma and dose equivalent (Riksmätplatsen). Apparently no formal Swedish national standards for activity or activity concentration exist, but SSI maintains reliable references for these quantities — an arrangement which cannot continue without laboratories at SSI. The radon and the whole-body counting laboratory as well as the laboratory for non-ionising radiation have especially important tasks.

It would perhaps be desirable to give either SSI or SP, the Swedish National Testing and Research Institute, the responsibility for keeping all the national standards for quantities connected with radiation protection, and the funds for doing so. The panel learned that SWEDAC, the Swedish Board for Accreditation and Conformity Assessment, would like to see a more comprehensive system of standards and quality control for products and services regulated by the radiation protection legislation.

IV.6 CONTINUITY AND VULNERABILITY

Outsourcing of laboratory activities and measurement capabilities should probably be regarded as a continuous process since both the quality and the availability of contract laboratories may change over time. Increased reliance on commercial laboratories puts SSI at risk of price increases, as there is little competition in this field, at least nationally. On the other hand the total contract value for external services is high enough to bring into force EU regulations on calling for tenders.

Several university laboratories fight with fluctuating budgets and often their laboratory activities depends on Ph.D. students and post docs whose employments are temporary. A more significant income from SSI would help to stabilise the budget for some of the present contract laboratories, but it cannot remove the problem. SSI has to keep track of the development for their present and future contract laboratories as is the case today within the nuclear emergency preparedness.

V. Conclusions and recommendations

V.1 GENERAL REMARKS

The evaluation panel recommends SSI to retain, and in some areas strengthen, key laboratory activities, for the following reasons:

- The public confidence in SSI would probably suffer if the competent national authority has to rely totally on external expertise for measurements.
- The ability and effectiveness of SSI to carry out inspections would suffer if the inspectors must use external services to make measurements, investigations and analyse samples.

- SSI's response to radiation incidents and accidents could be delayed without laboratory resources of its own.
- Laboratory activities within SSI are, in the opinion of the panel, essential for acquiring and maintaining expertise and institutional competence, especially in emerging areas, and for attracting and keeping well-qualified staff. Without laboratories a gradual decline of competence in width and depth would inevitably occur and SSI as an attractive and interesting working place could suffer in a scenario without laboratory facilities The approaching retirement of key specialists at SSI may accelerate this process.
- SSI should retain basic laboratory and measurement facilities in the key areas in order to avoid legal and commercial conflicts of interest.
- Outsourcing may appear to be financially attractive in the short term. However, once SSI has discontinued its own facilities it will have no alternative to using external services and paying what is demanded for those services.
- In some areas there is a lack of competent facilities, to which activities could be outsourced.

SSI administers the national standards (Riksmätplats) for kerma, absorbed dose and dose equivalent. The panel recommends that SSI extend this activity to cover other quantities necessary for the discipline of radiation protection, e.g. activity, activity concentration (especially of radon), surface activity, internal contamination and quantities necessary to characterise non-ionising radiation.

The panel suggests that SSI's name in English is changed to the 'Swedish Radiation Protection Authority' in conformity to BSS terminology and usage in neighbouring countries.

The following laboratory activities could, in the opinion of the panel, be outsourced:
- Routine measurements where methods are well established and when the research potential is minor.
- Continuous monitoring of normal environmental situations for emergency preparedness.
- Collecting data in routine environmental surveillance programs for assessment purposes.

V.2 SPECIFIC RECOMMENDATIONS ON SSI's LABORATORIES

With careful planning and outsourcing of some routine activities a smaller area than the present one would suffice for SSI's laboratories. However, care must be taken to keep the size of each laboratory activity large enough. Research and supervisory activities can support each other to keep the number of experts over the 'critical mass'. In the panel's opinion some laboratories already have been cut or allowed to decline below this level, and should be strengthened in order to survive. The specific recommendations for each laboratory activity area at SSI are (in arbitrary order):

- The radiochemistry laboratory and the attached counting room are important for SSI's activities concerning investigations, controls, environmental surveillance, research and development. The panel recommends that a radiochemist should be attached to the laboratory and be responsible for its functions.

- The panel finds that the activities concerning standards, references and calibrations for radon measurements are important activities in relation to SSI's ability to make its own measurements and to inspect and control measurements made by other laboratories. The work concerning standards, references and calibrations should be given primary national standard status.

- The continued development of retrospective radon dosimetry may be desirable but could be a part of SSI supported research at external laboratories.

- Radiation protection issues related to electromagnetic fields is one of eight areas given priority by SSI. Laboratory facilities at the present level should be planned also for the coming years. If the number of inspections and tests increases in the future outsourcing of the routine work should be considered, if suitable external laboratories exist.

- The panel recommends SSI to retain measuring capacity for ultraviolet radiation, as this area of radiation protection is likely to grow in importance. Routine control or certification of solarium facilities should be considered for outsourcing.

- The panel concurs with SSI's suggestion that the activities of the X-ray medical diagnostic laboratory could in the future be situated at a suitable medical establishment.

- The panel finds that SSI's capability for gamma-spectrometric measurements is indispensable for inspections, tests of radiation sources, control of other laboratories and for research and development. The capacity should be retained at the present level.

- The ability to measure internal contamination by whole-body counting is vital for SSI's work with criteria, norms, inspections and research, bearing in mind the EU requirement to document internal exposure. SSI's laboratory also has a leading role in the intercalibration of Swedish and Nordic whole-body counting facilities. The panel recommends that SSI retain a whole-body facility, possibly reduced in size.

- The opinion of the panel is that the GIS- and field gamma-laboratory is highly cost-effective and fulfils vital needs in modern radiation protection for the competent authority and it is recommended to continue this activity in order to further develop SSI's capability of a fast response to a nuclear event.

V.3 RECOMMENDATIONS ON CONTRACT LABORATORIES

Emergency preparedness

The contract laboratories are well established with a high level of expertise and with adequate equipment. The laboratories play an important role in the Swedish emergency preparedness system. The actual emergency capacity and response time for an emergency preparedness system is always difficult to assess, yet these factors are crucial for any emergency preparedness.

The panel recommends:

- To introduce small scale emergency exercises without previous warning, in order to test the availability, the capacity, and the response time of the contract laboratories. The possibility of these exercises should be mentioned in the contract and reflected in the economic compensation.
- To concentrate the efforts on fewer and larger contract laboratories in order to strengthen the continuity. The smaller of the contract laboratories still carry expertise of potential importance for the emergency preparedness. These laboratories should be supported through SSI's research contracts rather than having a fragile role in the emergency preparedness system.

Routine measurements

The possible outsourcing of routine measurements in the coming years may concern environmental monitoring of the normal situation for emergency preparedness, parts of the EU-initiated environmental surveillance, and control and certification of EM and UV devices. Among the present contract laboratories there are only limited possibilities for the introduction of routine measurement programmes as part of their contracts. The panel recommends to consider commercial laboratories as possible new contract laboratories for the routine measurement services.

Appendix A

I. The Director-General's directive for the evaluation

Directive No 15/2438/00 (in Swedish)

Generaldirektören **Beslut** 2000-09-04 Dnr 15/2438/00

Direktiv för uppdrag att utreda SSI:s framtida behov av mätresurser för strålning och radioaktivitet

Bakgrund

För att säkerställa en för SSI kostnadseffektiv organisation för mätning av strålning och radioaktivitet i prover, i miljön och i människor, behöver myndighetens totala behov av laboratorieresurser för kommande decennium inventeras. Målet är en väl fungerande laboratorieverksamhet med resurser och kompetens i paritet med de behov som förutses, dvs. rätt nivå i förhållande till behoven.

Uppdraget

Generaldirektören uppdrar åt Avdelningen för Miljöövervakning och mätberedskap att i samråd med GD-staben utreda SSI:s framtida behov av mätresurser avseende strålning och radioaktivitet, samt ange vilka egna respektive externa (upphandlade) laboratorieresurser som krävs för att SSI ska kunna fullgöra sina uppgifter på ett bra sätt. Såväl fysiska som radiokemiska mätfrågor avseende tillsyn, miljöövervakning och beredskap ska ingå, dock ej Riksmätplatsen.

I uppdraget ingår att kartlägga befintliga, nationella laboratorier som kan bli aktuella, inklusive SSI:s egna. Härvid ska kvalitet, resurser och uthållighet (långsiktig kompetens/kompetensförsörjning inklusive SSI:s egen) analyseras. Laboratoriernas roll för den nationella beredskapen mot strålningsolyckor, det svenska miljöövervakningsprogrammet och strålskyddstillsynen ska redovisas. Skulle utredningen finna att det inom landet saknas nödvändiga laborativa resurser, ska de identifierade behoven specificeras.

Utredningen ska identifiera SSI:s behov av egna respektive upphandlade resurser och kompetenser. Dessa ska relateras till två framtida scenarier:

- SSI fortsätter att bedriva laborativ verksamhet med egen kvalificerad kompetens och i utrymmen med en lokalkostnad av 3000 kr/m^2.
- SSI förlitar sig på externa resurser och upphandlar tjänster och mätningar.

För varje scenario ska en uppskattning göras av dels en årlig kostnad för "normaldrift" av laboratorieverksamheten, dels en kostnadsuppskattning per utförd mätning (gammamätning på prover, kemisk analys av visst slag samt helkroppsmätning). Enklare mätningar utan laboratorieanknytning behandlas inte, t.ex. mätningar med handinstrument. Det är väsentligt att alla kostnader beaktas i dessa sammanhang, och eventuella intäkter till SSI från egen mätverksamhet ska medräknas. Det bör betonas att utredningen inte enbart syftar till en kostnadsminimering, utan till en behovsanpassning och optimering av resurserna där även kvalitetsaspekterna ska beaktas.

Som underlag för utredningen ska SSI ha sammanställt de olika forsknings- och utredningsuppdrag, föreskrifter, instruktioner och regleringsbrev som idag styr laboratorieverksamheten vid myndigheten. För att ge utredaren en klarare bild av den laborativa verksamhetens roll, ska SSI göra en sammanställning av vilka analyser, mätningar och relevanta forskningsprojekt som SSI utfört eller låtit utföra under de senaste fem åren, inklusive uppskattade kostnader.

Utredningen bör innehålla sakkunniga med oberoende ställning relativt de svenska laboratorierna och av en representant från SSI. Utredningen kompletteras med en referensgrupp bestående av representanter för myndigheter, universitet och industri. Utredningen finansieras med SSI:s forskningsmedel och ska avlämna sin rapport senast 2001-04-30.

Beslut i detta ärende har fattats av generaldirektör Lars-Erik Holm. I beslutet har närvarit avdelningscheferna Gunilla Hellström, Carl-Magnus Larsson och Hans Mellander. Föredragande har varit ställföreträdande generaldirektör Ulf Bäverstam.

STATENS STRÅLSKYDDSINSTITUT

Lars-Erik Holm

Ulf Bäverstam

II. Amendments suggested by the evaluation panel

Letter (in danish) from the evaluation panel to SSI's Director-General Lars-Erik Holm, 20 March, 2001:

Kære Lars-Erik Holm

Ved udredningsgruppens seneste møde hos SSI den 6. - 7. marts 2001, fortsatte vi drøftelsen af den opgave, som defineres i direktivet for udredningsarbejdet.

Direktivet foreskriver en udredning af SSIs fremtidige behov for måleressourcer mht. stråling og radioaktivitet, samt en angivelse af hvilke interne (i.e. SSIs egne) og eksterne (i.e. kontraktaftalte) laboratorieressourcer vedrørende tilsyn, miljøovervågning og beredskab, som kræves for at SSI kan løse sine opgaver på en god måde.

Udredningen skal relateres til to scenarier: et hvor SSI fortsætter med at drive egne laboratorier, og et hvor SSI alene baserer sig på eksterne laboratorier.

Som et led i udredningen ønskes en kortlægning af eksisterende nationale laboratorier, som kan blive aktuelle, dvs. nuværende og mulige nye kontraktlaboratorier samt SSIs egne laboratorier. Kortlægningen skal omfatte en analyse af kvalitet, ressourcer, og bestandighed samt en økonomisk analyse, der føres frem til en opgørelse af omkostninger per udført måling. Laboratoriernes rolle i beredskabet, miljøovervågningen og strålingsbeskyttelsestilsynet skal gennemgås.

Udredningsgruppen har forstået direktivet således, at opgaven består af to dele:

I. En analyse af SSIs behov for måleressourcer, samt hvor skillelinien mellem interne og eksterne laboratorieressourcer skal placeres, for at SSI kan løse sine opgaver på en god måde. Analysen vil omfatte en gennemgang af de nødvendige måleressourcer og en redegørelse for de nuværende kontraktlaboratoriers rolle. Analysen må også behandle spørgsmål vedrørende SSIs målsætning for laboratoriearbejdet, SSIs troværdighed som tilsynsmyndighed, hvilke interessekonflikter, der kan være knyttet til balancen mellem interne og eksterne laboratorier, spørgsmål om eksterne laboratoriers kontinuitet og eventuelle sårbarhed samt langsigtet kvalitetssikring og kvalitetskontrol.

II. En kortlægning af eksisterende svenske laboratorier, som i øjeblikket bidrager til, eller som vil kunne bidrage til det nødvendige målearbejde inden for strålingsbeskyttelsesområdet. Kortlægningen forudsætter, at laboratorieopgavernes art, omfang og kvalitetsniveau defineres. Kortlægningen vil kræve indkaldelse af tekniske og økonomiske oplysninger og evt. egentlige tilbud fra de mulige eksterne laboratorier, en proces som sandsynligvis skal være åben for alle relevante laboratorier ifølge EU-reglerne.

Udredningsgruppen ser opgave I som sin centrale opgave i det foreliggende arbejde.

Opgave II er primært af teknisk-økonomisk karakter, men inddeholder også juridiske aspekter i forbindelse med en eventuel tilbudsgivning. Opgaven kan muligvis igangsættes sideløbende med opgave I.

Vi vil derfor foreslå:
- At udredningsgruppen løser opgave I og fremkommer med en anbefaling af balancen mellem interne og eksterne laboratorieressourcer, idet det *a priori* antages, at ekstern laboratoriekapacitet er billigere end intern laboratoriekapacitet. Udredningsgruppen afleverer sin rapport som aftalt, senest den 30. juni 2001.

- At SSI løser opgave II og derefter drager sin konklusion vedrørende den ønskede balance mellem intern og ekstern laboratoriekapacitet.

Til din orientering har jeg vedlagt udredningsgruppens første udkast til disposition for rapporten vedrørende opgave I.

Vi håber, at vi med dette forslag kan bidrage til en effektiv gennemførelse af laboratorieudredningen.

Med venlig hilsen,
på udredningsgruppens vegne,

Anders Damkjær

Appendix B

Radiation protection and nuclear emergency management in Norway, Denmark and Finland

I. Norway

I.1 Norwegian Radiation Protection Authority (NRPA)

In Norway the 'Norwegian Radiation Protection Authority', NRPA, under the Ministry of Health and Social Affairs is the competent regulatory authority for radiation protection mandated through legislation. In this function NRPA has in operation several measurement and laboratory facilities for radiation measurements and monitoring. These activities shall serve several main goals in order to make NRPA operable in functions such as:

- Maintain and develop competence in NRPA as the competent authority
- Serve as the main national resource in nuclear emergency preparedness
- Monitor the radiation exposure situation for humans and environment
- Inspection of human practices involving radiation sources
- Co-operation with other national or international institutions.

The main laboratory activities at present are:

1. Dosimetry laboratory for ionising radiation. This is a calibration laboratory with status as a secondary standard laboratory, SSDL and participates in the EUROMET network. Its products are calibrations certificates to customers with such needs, mainly hospitals involved in medical radiation therapy.

2. Radio-analytical laboratories at NRPA. The NRPA radio-analytical laboratory at Østerås performs laboratory measurements of radioactivity in foodstuffs and environmental and air samples. The main purpose is to serve internal needs for radioactivity measurements for monitoring programs, emergency preparedness and research projects. The laboratory is equipped for radio nuclide determination by low-level high-resolution gamma spectrometry, alpha spectrometry, liquid scintillation counting and beta counting and whole-body gamma measurements. Analysis performed routinely includes gamma emitters, plutonium isotopes, americium-241, polonium-210, technetium-99 and strontium-90. Whole-body measurements of critical groups for Cs-137 intake are performed every three years with mobile equipment. In addition, laboratory personnel regularly participates at field expeditions and sampling campaigns in marine and terrestrial environments.

   The laboratory maintains an accredited quality control system for gamma spectrometric measurements in compliance with the EN 450001 standard. In the year 2002 it is expected that the accreditation will be extended to include radiochemical methods.

   The laboratory serves as a reference laboratory for the LoRaKon (Local Radioactivity Control) network. This is a network of laboratories for analysis of radioactivity in foodstuffs.

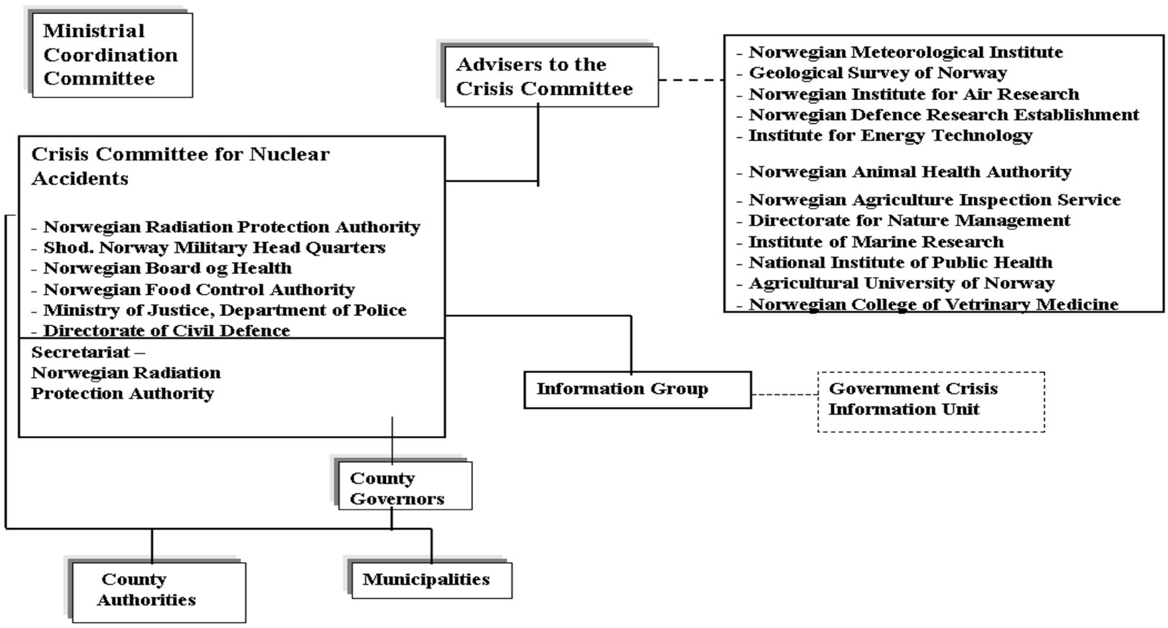
   At Svanhovd, in the north of Norway, an emergency preparedness unit was established in 1993. The unit is equipped for high resolution gamma spectrometry, and performs measurements of air filters and other environmental samples.

Last year, the NRPA established a small unit at the Polar Environmental Centre in Tromsø. A laboratory for gamma spectrometric measurements and technetium-99 will be operational by 2002.

3. Optical laboratory. This laboratory measures ultraviolet radiation and serves mainly as a calibration laboratory, but some routine measurements are also performed for inspection purposes and type approval of products. This laboratory is a key element in the national monitoring of natural ultraviolet radiation.

4. Laboratory for radiation biology. This unit is mainly working in basic research projects with developing methods and procedures in connection with radiobiological effects on cellular systems and bio molecular systems both for ionising and non-ionising radiation exposure.

In a nuclear emergency situation larger laboratory and measuring resources are available through an established network of Cupertino institutions. The main principle here is that every Ministry with some kind of responsibility in such a situation has to take responsibility for making their competence and resources available. This principle is laid down in special legislation and regulations and a co-ordination body is established: 'The crisis committee for nuclear accidents'. The organisational overview is shown below. In the group of advisors to the crisis committee several types of measuring systems and laboratory resources are available.



I.2 The Norwegian Nuclear Emergency Organisation

Based on the Royal Decree 26. June 1998, the Government decided to establish the above Organisation made up of representatives of the following entities:

- the Ministries;
- the Ministerial Co-ordination Committee;
- the Crisis Committee for Nuclear Accidents;
- the Advisors to the Crisis Committee for Nuclear Accidents;

- the Secretariat for the Crisis Committee;
- the regional emergency organisations.

The Ministries are totally responsible for emergency preparedness in their area of competence. In order to deal effectively with the early phase of a nuclear accident, the Ministries have transferred responsibility for remedial actions to the Crisis Committee for Nuclear Accidents.

The Ministerial Co-ordination Committee is responsible for ensuring co-operation and co-ordination between the different Ministries. Its members are the Ministries of Health and Social Affairs, Justice, Defence, Foreign Affairs, Environment, Agriculture, Fisheries, Trade and Industry, Education Research and Church Affairs, and Transport and Communications. The Ministry of Health and Social Affairs heads the Committee.

The Crisis Committee for Nuclear Accidents is made up of representatives of the following institutions:

- the Norwegian Radiation Protection Authority;
- the Directorate of Civil Defence and Emergency Planning;
- the Norway Military Headquarters;
- the Police Department of the Ministry of Justice;
- the Norwegian Board of Health;
- the Norwegian Food Control Authority.

The Committee is responsible for deciding and implementing remedial actions in case of a nuclear accident or an impending nuclear accident representing a potential threat to Norway. It must organise the evacuation of the population if the situation represents a direct threat to health and life; provide shelter, administer stable iodine, block and secure contaminated areas; in the short term restrict production and distribution of foodstuffs; and advise on dairy products. The Norwegian Radiation Protection Authority heads the Committee.

Wherever possible, the Committee must discuss its decisions with the Ministries before acting on such decisions.

The Advisors to the Crisis Committee for Nuclear Accidents is made up of representatives of twelve organisations and institutions with expertise and responsibility required for an emergency organisation, both as regards the management of nuclear accident situations and for further development and maintenance of emergency preparedness. Its members include the Norwegian Defence Research Establishment, the Institute for Energy Technology, the Norwegian Meteorological Institute, the Geological Survey of Norway, the Norwegian Agricultural Inspection Service, etc.

During accident situations, the tasks of the Advisors are to:

- submit and make available all information, data and measurements of relevance to the emergency situations and make forecasts for radioactive dispersion, fallout and radiation doses to the public;
- advise on preventing or reducing the radiological and economic consequences of a nuclear accident in Norway.

The Secretariat for the Crisis Committee (the Nuclear Safety Department in the Norwegian Radiation Protection Authority) is responsible, *inter alia*, for alerting the Nuclear Emergency Organisation and for warnings in an emergency situation. The Secretariat also organises a telephone watch so that the Organisation can be alerted at all times.

The Regional Emergency Organisations are established under the direction of the Chief Administrative Officers in the Norwegian counties.

I.3 Comparison between SSI and NRPA

When comparing SSI and NRPA with respect to laboratory functions there are many similarities but also some important differences. These differences can partly be traced to different obligations given to the institutions from their respective ministries. A major difference is the system of contract laboratories, which does not exist in Norway. SSI is in a position also to initiate radiation protection research activities outside SSI with economical support. The fact that Sweden has several nuclear power plants and Norway only two research reactors has resulted in quite different systems for nuclear emergency management in the two countries. Both factors have probably made it possible to have a number of potential contract laboratories in Sweden. The same type of laboratory functions can be found at NRPA but the resources available are different. As a rough estimate it can be mentioned that NRPA has less space and equipment for its whole body laboratory, perhaps more space and equipment for radiochemical analysis, less dedicated space for radon measurements, and comparable space for optical and X-ray laboratory activities. The radiochemical laboratory at NRPA has been updated the last years and for the time being a considerable amount of samples are measured in relation to marine radioecology. At NRPA there is no laboratory for electromagnetic fields, only commercial measuring instruments are used. A dedicated field-gamma laboratory do not exist so far at NRPA but NRPA is responsible for the radioactivity part in AMAP (Arctic Monitoring and Assessment Program) where measuring results are fed into a GIS system.

II. Denmark

II.1 The National Institute of Radiation Hygiene (NIRH)

NIRH is the Danish regulatory authority in the field of radiation protection. The institute is under the jurisdiction of the Ministry of Health and refers to that ministry concerning the X-ray legislation and to the Ministry of Interior concerning the radioactivity and the nuclear facilities legislation.

The primary tasks for the institute comprise:

- Issuing of legislation.
- Regulatory function concerning X-ray facilities and radioactive substances.
- Information and guidance to employees, institutions, companies, the public, and other authorities.
- Standardisation.
- General supervision of radiation and radioactivity.

NIRH has ca. 25 employees and an annual budget of ca. 12 million DKK. The income from fees and services was 1.2 million DKK in 1999. Besides the administrative and technical support functions, the work is presently organised in 4 divisions:

<u>The X-ray Division</u> is responsible for permissions, inspections, standardisation and quality control in relation to X-ray facilities in hospitals, industry, and research etc. The division has 5 academic employees.

<u>The Radioactivity Division</u> is responsible for licensing, inspections, education and advising regarding the non-medical use of radioactive substances, natural radioactivity and transport. The division also deals with emergency preparedness and preparing regulations together with standardisation. The division has 6 academic employees.

The Division for Dosimetry and Radioactivity Measurements is responsible for standards and references for dosimetry and activity measurements, control and calibration of radiation monitors, and licensing of personnel dosimetry services. Additionally the division is responsible for licensing, quality control, inspections, education and advising regarding the medical use of radioactive substances The division has 1 academic and 1 laboratory technician as its staff.

The Personnel Dosimetry Laboratory is responsible for a personnel dosimetry service which is based on photographic films. This service covers all Danish workplaces using ionising radiation, except Risø National Laboratory who is using the licensed dosimetry service at Risø and the hospitals in the county of Århus who are using a licensed dosimetry service based on TLD. The division has 1 academic and 2 assistants as its staff.

Laboratory facilities.

Besides the laboratory for dosimetry films, NIRH has a radiochemistry laboratory, a low level gamma-laboratory, a gamma- and X-ray calibration laboratory, and X-ray facilities for educational purposes.

The radiochemistry facility consists of a ca. 40 m^2 class C (IAEA) laboratory used for the physical preparation of soil samples for gamma spectroscopy and urine samples for gross beta counting, in the year 2000 adding up to about 250 samples.. Although this facility is not used today for chemical separation work, it could easily be upgraded to preparatory work for Sr-90 and Cs-137 analysis. In addition the radiochemistry has a ca. 20 m^2 class B laboratory used for handling of relatively high-activity radioactive solutions. This facility is used for preparation of radioactive standard solutions for medical purposes. The operations involved are dilutions and preparation of carrier solutions including pH adjustments.

The low level gamma-laboratory has one 30% HPGe spectrometer, which was used intensively for measuring the natural radioactivity of soil samples during the recent national radon survey. The spectrometer is used on a routine basis for quality control of radioactive standard solutions prepared in the radiochemistry laboratory. The spectrometer also serves as a stand by instrument for analysis of samples suspected of a radioactive contamination or otherwise unknown sources. The laboratory also has a 5% Ge(Li) detector as a back up for the larger one.

Additionally the laboratory has a TLD-system, which in year 2000 handled approximately 3600 TLDs, primarily ordered by the X-ray division or the Radioactivity Division for additional dose control.

The gamma- and X-ray calibration laboratory has a Co-60 and a Cs-137 irradiation facility and an X-ray set-up with a remotely controlled trolley system. Both facilities are used for calibration of NIRH's film based personnel dosimeters and for calibration of a variety of instruments used at Danish hospitals.

The X-ray education facility has 5 X-ray set-ups which are used for the training of hospital personnel. The training courses are organised and run by NIRH.

The first three laboratory facilities are primarily used by the Division for Dosimetry and Radioactivity Measurements.

External laboratory- and measurement services

The Danish surveillance programme for radioactivity in the environment is at present carried out by Risø National Laboratory. Risø is operating a continuos air monitor with a weekly filter change. The filter is analysed for Cs-137, Sr-90, Be-7, and Pb-210. Ground water and surface water are collected at the order of 500 samples per year and analysed for H-3, Sr-90, and Cs-137. Samples of grass, soil and a variety of foodstuffs are collected regularly and analysed for

Cs-137, Sr-90, and K-40. The environmental surveillance programme, which represents a work-load of 1 to 2 man-year, is presently under adjustment in order to cope with the recommendations of Article 35 and 36 of the Euratom Treaty.

NIRH and the Danish Nuclear Emergency Preparedness

NIRH is represented in the Advisory Committee (§9,2 committee) under the Danish nuclear emergency management organisation (see below under the Emergency Management Agency), where NIRH contributes with its expertise in health physics and radiation protection.

NIRH participates in the routine emergency surveillance duties, including the surveillance of the early warning system against fallout.

In case of a nuclear emergency, it will be the task of NIRH to organise measurement programmes concerning radioactive contamination, with assistance from hospital- and university laboratories. In addition NIRH will be responsible for the co-ordination with the general health care system.

II.2 The Danish Emergency Management Agency (DEMA)

The Nuclear Division of DEMA (‘Beredskabsstyrelsen’) under the jurisdiction of the Ministry of Interior, is the Danish regulatory authority concerning nuclear facilities and is responsible for the nuclear emergency preparedness system. The regulatory function concerning Risøs nuclear facilities is shared with NIRH. In addition the Nuclear Division has the task of maintaining an adequate level of information concerning nuclear facilities in the vicinity of Denmark.

The Nuclear Division of DEMA has 10 employees and an annual budget of about 8 million DKK. Besides the administrative and technical support functions, the work is presently organised in 3 groups. <u>The Safety- and Information group</u> is responsible for the inspection- and regulatory work concerning nuclear facilities (i.e. Risø), physical protection of transports, answering questions from parliament and ministries, co-ordination of multilateral assistance to Eastern countries, development and implementation of a web-based nuclear information system for Denmark and the Baltic countries etc. The <u>Consequence analysis- and measurement group</u> is responsible for the Danish early warning system (PMS) against radioactive fallout, for DEMA's mobile measurement facilities and for the ARGOS decision support system. Finally, the <u>emergency preparedness group</u> is responsible for the nuclear emergency preparedness planning.

The Nuclear Division has no laboratories of its own, apart from a small electronics and IT workshop. The development of the software and the technical facilities for the nuclear emergency preparedness is initiated and financed by the Nuclear Division. The Technical University of Denmark, Risø, the Danish Meteorological Institute, and two commercial companies have all participated in this development under contracts with the Nuclear Division.

The Nuclear Division is in charge of the Danish nuclear support programme for the Baltic region which has an annual budget of ca. 15 million DKK. This programme aims at safety improvements at the nuclear power plants in Russia and Lithuania and improvements of the nuclear emergency preparedness programmes in these countries and in Estonia, Latvia and Poland.

The Danish Nuclear Emergency Preparedness

In a nuclear emergency situation, the DEMA acts as head of the Central Emergency Management (CEM), which has representatives from police, defence, governmental- and municipal institutions. The CEM has the operative and administrative responsibility in the situation and its decisions are conferred with the Advisory Committee (the §9,2 committee), which has representatives from DEMA, NIRH, and Risø. When the emergency situation is declared, the Advisory Committee becomes part of the CEM.

II.3 Risø National Laboratory

From the start in 1956 and up to the mid eighties Risø's mission as a national laboratory was to pave the way for the utilisation of nuclear power in Denmark. In 1985 the Danish parliament, Folketinget, decided that nuclear power should no longer play a role in the Danish energy planning, and the following year Risø's mission was changed to that of a general national laboratory with energy as the main field of research and development. Today, Risø's four strategic areas are Energy, Industrial Technology, Bioproduction and Radiation Safety. Risø's Department of Nuclear Safety Research (one of Risø's 7 research departments) works with radioecology, dosimetry, emergency preparedness and reactor safety. In addition an interim department, 'Risø Decommissioning (RD)', has recently been established. It encompasses Risø's present nuclear facilities including the facilities for treatment of radioactive waste. RD is planned later to be an independent organisation with the task of decommissioning of Risø's nuclear facilities and the establishment of a permanent Danish repository for radioactive waste.

As mentioned above, Risø co-operates closely with NIRH and DEMA in the field of radiation protection and nuclear emergency preparedness. Risø's major tasks in this co-operation are:

- Monitoring of radioactivity in the environment including sampling of ground water, surface water, soil, vegetation, and foodstuffs.
- Operation of a continuous air sampler with a filter change once a week.
- Surveillance and maintenance of the 11 Danish automatic early warning stations against radioactive fallout.
- Treatment and interim storage of all radioactive waste generated in Denmark.
- Participation in the Advisory Committee (§9,2 committee) under the Danish nuclear emergency management organisation, where Risø contributes with its expertise in reactor physics, health physics, and radioecology.
- In case of a nuclear emergency, Risø's members of the Advisory Committee will become members of the Central Emergency Management. It will be the task of Risø to organise and carry out measurement programmes concerning radioactive contamination.

Risø maintains through its research activities a considerable capacity for measurements of radioactivity in the environment, in foodstuffs, and for radon in indoor air, a capacity which is also used for commercial expert services.

II.4 Comparison between SSI and the corresponding Danish institutions

The main difference between Sweden and Denmark, as far as radiation protection and nuclear emergency preparedness are concerned, is that Denmark has no nuclear power plants within its borders. The three research reactors DR 1, DR 2, and DR 3 at Risø, are the only Danish nuclear reactors and they are all now entering the process of decommissioning. The amount of radioactive material present in the country is therefore far less in Denmark as compared to Sweden.

The institutional organisation behind radiation protection and nuclear emergency preparedness is different in the two countries. The Danish organisations are NIRH, DEMA and Risø. NIRH and DEMA share the responsibility of being the regulatory authority concerning nuclear facilities, similar to SKI's function in Sweden, although on a much smaller scale.

NIRH is the Danish regulatory authority concerning radiation protection, similar to most of the tasks for SSI in Sweden. However, NIRH has very limited possibilities for research activities of its own or funding of external research.

NIRH's laboratory facilities are described above. One difference between NIRH and SSI is that NIRH is in charge of the Danish Personnel Dosimetry Laboratory, whereas this function in

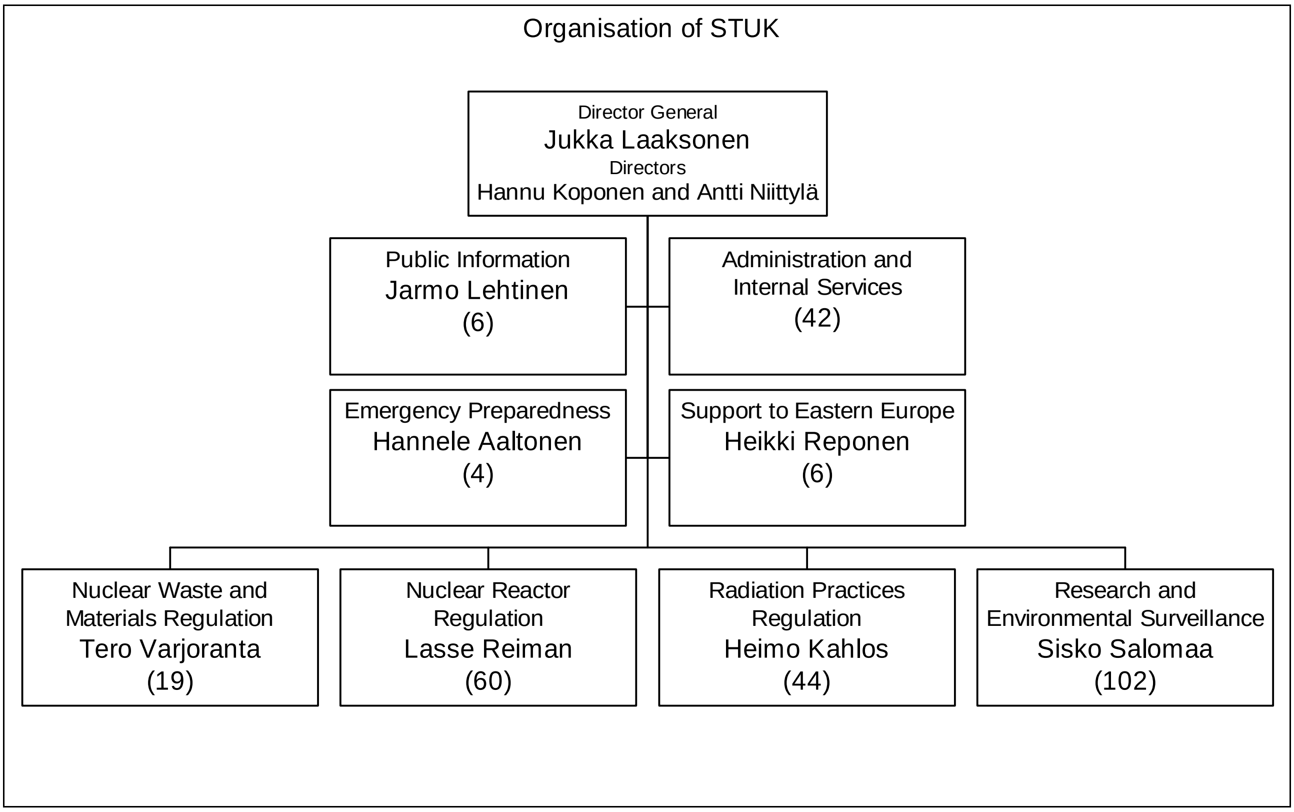
Sweden is placed outside SSI. NIRH's laboratory resources for general dosimetry and radiation measurements amounts to 2 man-years per year. Risø is in charge of the Danish environmental monitoring and yields approximately 2 man-years per year for this task. This gives a total of 4 man-years per year of laboratory resources for radiation protection duties excluding research. This is to be compared with SSI’s laboratory resources of about 6 man-years per year which include the research activities. Neither Risø nor NIRH have any research progammes concerning radiation protection against non-ionising radiation.

DEMA has, like NIRH, only very limited possibilities for research of its own. However, DEMA is in charge of the Danish nuclear support programme for the Baltic region which has an annual budget of 15 million DKK for external contracts.

III. Finland

III.1 The Radiation and Nuclear Safety Authority (STUK)

The Radiation and Nuclear Safety Authority, commonly known by the acronym STUK, is a regulatory authority, research institution and expert organisation, whose mission is to prevent and restrict any harmful effects of radiation. As is evident from the name both radiation and nuclear safety are implied, i.e. STUK combines the functions of SSI and SKI in Sweden. STUK was founded in 1958 as the Institute of Radiation Physics, and now has 267 employees. STUK is subordinate to the Ministry of Social Affairs and Health. The organisation chart is shown below; numbers in brackets show the numbers of employees.



Organisation of STUK

An international panel recently evaluated the research activities of STUK. The evaluation report is available on the Internet[i]. The opening paragraph of the report is relevant to the SSI Laboratory Evaluation and is quoted below:

'Research is essential to underpin the effective functioning of STUK and the quality of its advice. The need for research to support the work of STUK is not in dispute; where it should be performed is, however, more open to question. In principle, some or all of the research could be outsourced with STUK maintaining only a commissioning and monitoring role. The Panel concluded, however, that any move in this direction should be strongly resisted. Maintaining a considerable level of research within STUK was judged to be essential for acquiring and maintaining expertise, especially in emerging areas, and for attracting and keeping well-qualified staff. In its absence, a gradual decline in competence would inevitably occur, in particular in a field that is now relatively mature and, consequently, less appealing to young scientists.'

The annual budget of STUK was 129,4 MFIM (21,8 M EURO). The financing is broken down by source in Table B-1[ii].

Table B-1. Financing of activities 2000.

Source	M EURO	%
Funding allocations from the State	9.0	42
Income from monitoring under public law	6.2	29
Expert services	5.1	23
External funding for joint ventures	1.1	5
Other, e.g., funding by Ministry of the Interior, employment assistance	0.4	2
Total financing	21.8	100

The use of personnel resources is shown in Table B-2.

Table B-2. Use of working time 2000.

Activity	Person-years	%
Research	67.18	29
Nuclear safety	56.74	24
Administration and internal services	36.35	16
Expert services	27.49	12
Radiation safety	18.86	8
Environmental radiation monitoring	8.16	3
Preparedness	10.37	4
Communications	9.22	4
Total	234.37	100

Research is, as Table B-2 shows, the major activity at STUK. Each year about 70 working years and 6.3 M EURO are invested in research. STUK has adopted the Quality Management system. The main laboratory functions were accredited by FINAS in 1999 (T167/EN45001). Quoting from the Evaluation Report:

'The research facilities of STUK are excellent by any international standards. The new premises for STUK were built 1994 in Roihupelto, East Helsinki. This provided not only new laboratory facilities and equipment, but perhaps more importantly, brought together a critical mass of experts that previously had worked at separate sites all over the Helsinki area. Bringing together all the main groups covering fields of radiation and nuclear safety expertise creates a strong synergy benefit. Outside Helsinki, STUK has one regional laboratory in Rovaniemi, which specialises in sub-arctic and arctic ecosystems.'

'At the national level, STUK's research networks involve eight universities and technological universities and all major governmental research institutions dealing with health, environment

and foodstuffs, as well as a number of technological research centres. Technical development has been carried out with several companies and a number of domestic collaborators have acted as suppliers of samples and data.'

'During the last five years, STUK has been involved in about 40 research projects and concerted actions funded by the European Union. In several of these, STUK has acted as co-ordinator. At the national level, the most important sources for external research funding have been Academy of Finland and the National Technology Agency (TEKES). The external funding of STUK has increased from 0.58 M EURO in 1995 to 1.36 M EURO in 1997, but is still at a small level. The main funding is provided by the state budget, guaranteeing continuity and a basis for long-term planning of the organisations activities.'

Most of the research activities are carried out in the **Department of Research and Environmental Surveillance**, headed by Professor Sisko Salomaa. The laboratory activities at STUK are also mostly found in this department, the sub-units of which are called *laboratories*. They are listed in Table B-3, with the numbers of researchers and laboratory technicians indicated.

Table B-3. Laboratories in the Department of Research and Environmental Surveillance.

Laboratory	Researchers	Technicians	Total
Natural Radiation	9	8	17
Nuclear Power Plant Environment	5	4	9
Ecology and Food Chains	6	5	11
Regional Laboratory in Northern Finland	3	4	7
Radiation Hygiene	6	1	7
Airborne Radioactivity	10	4	14
Medical Radiation	5	1	6
Radiation Biology	17	4	21
Total	61	31	92

The remaining ten persons in the Department work in the Management Unit or with Emergency Preparedness.

In a recent interview[iii] Professor Salomaa said: *'It is one of the strengths of STUK that the same organisation in Finland is responsible for radiation and nuclear safety and is engaged in research. We have a lot of cross-scientific know-how and comprehensive visions. We are also acquainted with the practical side of e.g. environmental radiation monitoring and know how it needs to be developed. This is an advantage of a small country and this kind of organisation. In many larger countries the competent authority does not carry out research. Moreover, there usually are different authorities for radiation and nuclear safety, possibly even a separate one for non-ionising radiation. Compartmentalisation may mean that authority functions and research live lives of their own, and practical application of research results may take a long time.'*

Apart from the research facilities listed above the **Department for Radiation Practices and Regulations** also has two laboratories: the Radiation Metrology Laboratory (5 scientists and 2 technicians) and the Non-Ionising Radiation Laboratory (8 persons).

A **comprehensive list** of STUK's research projects is found in a STUK publication[iv]. The Evaluation Report[i] also lists the research projects, together with the Evaluation Panel's recommendations.

III.2 Comparison between SSI and STUK

The dissimilarities between SSI and STUK relevant to the Laboratory Evaluation are mostly related to STUK's continuing investment in research. The laboratory functions necessary for research support those required for the Authority's supervisory functions, and vice versa. Thus the critical mass for laboratory activities is achieved within most sub-disciplines of radiation protection. Some of the relevant dissimilarities are listed below.

Expert services. Many of the analytical services of STUK are available to outside organisations and the general public against payment. The radioanalytical determinations described under the first three bullets below are available at SSI, but since resources are limited SSI does not wish to compete with commercial laboratories. The services offered by STUK include:

- Determination of the natural radioactivity in water.
- Gammaspectrometric measurements.
- Determination of alpha and beta emitters, e.g. tritium, strontium, transuranics, polonium and lead.
- Determination of internal contamination. The nuclear power plants are required to have simple whole-body counters, but more exact determinations are done in STUK's mobile unit, especially during revisions. The Radiation Hygiene Laboratory also analyses urine or faeces for beta and alpha emitters. At SSI private persons and employees of enterprises using open sources can, if necessary, have their body burden determined against payment.
- Biological dose determination by chromosome aberration analysis. Not offered by SSI.
- Determination of radon in dwellings and places of work. STUK does more than 90% of the radon determinations by track etching in Finland. The commercial company Gammadata is established in Finland but so far handles only a minor portion of the determinations. Some local authorities also possess instruments for radon determination. SSI does not offer this service to the public.
- Determination of the external dose to radiation workers. This service is about to be outsourced for reasons of principle, as SSI already has done. STUK will continue to keep the national dose register.

Calibration and testing. The Radiation Act requires STUK to hold national standards for radiation units and to provide calibration for radiation instruments. The quantities involved include exposure rate, air kerma rate, dose rate, dose equivalent rate and surface activity. The traceability of the national standards is described in detail in the annual statistical survey of STUK[v].

Radioactive waste disposal. STUK administers the national disposal unit for small quantities of solid radioactive wastes. In 2000 STUK received 37 shipment totalling 1.92 tons of waste. Users of this service have to pay a fee per unit volume or unit mass of waste, including the necessary shielding.

Regional Laboratory in Northern Finland. STUK maintains a regional laboratory in Rovaniemi, which specialises in sub-arctic and arctic ecosystems. This laboratory is especially important for activities concerning the Kola Peninsula and the radiological legacy of the former Soviet Union.

Mobile Whole-Body Counter. The mobile unit mentioned above is also used for surveys of population groups at risk, e.g. the reindeer-herding Sami population. SSI also owns a mobile unit, but has outsourced its operation to FOI Umeå.

Contract Laboratories. SSI relies in part on a system of Contract Laboratories for emergency preparedness. STUK does not have quite the same system, as no annual compensation is involved. However, there are about fifty local laboratories that do have tasks in an emergency. The laboratories have received their (not very sophisticated) equipment from STUK, and STUK also has undertaken to provide instruction to the laboratory staff and to provide calibration and service for the equipment. The laboratories have, by written agreement, undertaken to participate in emergency measurements upon an alarm from STUK. In return the laboratories may use the equipment and know-how for revenue-earning purposes.

SOURCES

[i] Evaluation report, www.stuk.fi/julkaisut/STUKevaluation.pdf

[ii] Annual report for 2000, www.stuk.fi/publications/

[iii] Virtanen, H.: STUK on suuri tutkimuslaitos. ALARA **10:1** (2001) 4-6 ('STUK is a large research establishment', in Finnish)

[iv] Research projects of STUK 2000-2002, STUK A179, June 2000

[v] Säteilyn käyttö ja muu säteilytoiminta. Vuosiraportti 2000. STUK-B-STO-43, 2001. (Statistical survey for 2000, in Finnish)

Appendix C

List of documents

List of documents submitted to the evaluation panel. Items 1 - 12 distributed 2000-12-19, items 13 - 32 before 2001-03-06, items 33 - 56 2001-03-07, items 57 - 62 distributed 2001-05-02, items 63 - 67 distributed 2001-05-(16-22).

N:o	Title	Author	File name or report number	Date or timestamp	Pages
1a	Utredningsdirektiv	GD Lars-Erik Holm	Laboratorieutredningsdirektiv.doc	2000-08-29	2
1b	Brev fra udredningsgruppen til GD Lars-Erik Holm	Anders Damkjær		2001-03-20	3
2	Regleringsbrev för budgetåret 2001 avseende SSI		Regleringsbrev 2001.doc	2000-12-19	8
3	Instruktion for SSI		SFS 1988:295, Förordning med instruktion för SSI.doc	2000-12-12	3
4	Den nationella strålskyddsberedskapen vid övergången till år 2000. Rapport.			1999-05-31	11
5	Organisationsschema för SSI				1
6	Broschyr: "Det handlar om ditt strålskydd"				8
7	SSI rapport "Säker strålmiljö"	Lynn Hubbard et al	1999:14		83
8	SSI Årsredovisning 1999	Lars-Erik Holm et al	21/476/00	2000-02-22	74
9	Strålskyddslag		SFS 1988:220	2000-05-13	9
10	Strålskyddsförordning		SFS 1988:293	2000-12-01	10
11	Utredningen "Långsiktig strålskyddsforskning"	Sören Mattsson	SOU 1994:40	1994-03	227
12	Avtal mellan SSI och Avdelningen för radiofysik, Lunds Universitet, Lund, om deltagande i den nationella strålskyddsberedskapen.	Robert Finck	73/354/00	2000-04-17	6
13	Tabell över bidrag till kontraktslaboratorierna		Bidrag till kontraktslaboratorierna.xls	2001-02-20	1
14	Klassificering (% arbetstid) av uppgifter för enskilda laboratorier vid SSI	Rolf Falk	SSI-laboratoriernas inriktning.xls OR Verksamheten vid SSIs laboratorier.xls	2001-02-15	1
15	Historiebeskrivning – Röntgenlaboratoriet	Wolfram Leitz	Röntgenlaboratoriet.doc	2001-02-05	1
16	Ickejoniserande strålning	Anders Glansholm	Labutredningen moment 2b.doc	2001-02-19	1

17	Helkroppslaboratoriet	Rolf Falk	Utredning om SSIs helkroppslaboratorium.doc OR Helkroppslaboratoriet vid SSI.doc	1999-11-09	12
18	Forskning och mätverksamhet vid SSI från 1980 och fram till år 2001	Ulf Bäverstam	I början på 80-talet.doc	2001-02-07	5
19	SSIs uppgifter utifrån regleringsbrev, instruktion och andra dokument	Lars-Erik Holm	Labutredningsunderlag från LEH.doc OR SSIs uppdrag mål och utgångspunkter.doc	2001-01-30	6
20	Laboratorier som svarat	Hans Mellander	Laboratorier som svarat 20010228.doc	2001-02-28	1
21	Kontraktslaboratorier	Lisbeth Falgert	Kontrakt-lab.doc	2001-01-16	3
22	Förfrågan om facklig profil	Hans Mellander	Förfrågan om facklig profil.doc	2001-02-08	1
23	Svar från SGU	Sören Byström	SGU svar till SSI.doc	2001-02-21	4
24	Svar från OKG	Christer Solstrand	OKG svar till SSI.doc	2001-02-27	1
25	Svar från SLU Alnarp	Inger Andersson		2001-02-15	1
26	Svar från MALÅ GeoScience	Jan Lundmark		2001-02-13	1
27	Svar från FOI Stockholm	Ingmar Vintersved		2001-02-21	2
28	Svar från FOI Umeå	Kenneth Lidström		2001-02-15	4
29	Svar från Medicinsk strålningsfysik, Karolinska institutet	Bo Nilsson		2001-02-15	2
30	Svar från Studsvik Nuclear	Robert Hedvall	Studsvik svar till SSI.doc	2001-02-15	11
31	Dokument utdelade till laboratorieutredningens ledamöter	Hans Mellander	Dokument till utredarna.doc	2000-12-19	1
32	SSIs arbete relaterat till laboratorieutredningen….	Hans Mellander	SSI arbete ang ref mtrl till lab utr.doc		
33	Redovisning av kontraktslaboratoriernas resurser	Micael Granström et al	FOA-R--99-01123-861--SE	1999-04	49
34	Beställningsbrev för SSI-projekt P1246 ”Medel till SLU Uppsala för att upprätthålla grundberedskap för mätning av radioaktiva ämnen inom lantbruket”.	Ulf Bäverstam	73/3310/88 SSI P 1246	2000-12-22	6
35	Avtal mellan SSI och Avdelningen för radiofysik, Göteborgs Universitet, om deltagande i den nationella strålskyddsberedskapen.	B. Åke Persson	73/356/00	2000-04-17	6
36	Avtal mellan SSI och Avdelningen för radiofysik, Linköpings Universitet, om deltagande i den nationella strålskyddsberedskapen.	B. Åke Persson	73/357/00	2000-04-17	6

37	Avtal mellan SSI och Avdelningen för radiofysik, Universitetssjukhuset MAS, Malmö, om deltagande i den nationella strålskyddsberedskapen.	B. Åke Persson	73/355/00	2000-04-17	6
38	Avtal mellan SSI och Institutionen för radiofysik, Umeå Universitet, om deltagande i den nationella strålskyddsberedskapen.	B. Åke Persson	73/359/00	2000-04-17	5
39	Avtal mellan SSI och Medicinsk radiofysik, Karolinska institutet, om deltagande i den nationella strålskyddsberedskapen.	B. Åke Persson	73/358/00	2000-04-17	5
40	Avtal mellan SSI och Studsvik Nuclear AB, Nyköping, om deltagande i den nationella strålskyddsberedskapen.	B. Åke Persson	73/361/00	2000-04-17	6
41	Avtal mellan SSI och Avdelningen för NBC-skydd, Försvarets forskningsanstalt, Umeå, om deltagande i den nationella strålskyddsberedskapen.	B. Åke Persson	73/360/00	2000-04-17	6
42	Avtal mellan SSI och Försvarets forskningsanstalt om drift av luftfilterstationer inom ramen för den nationella strålskyddsberedskapen 1/1 1999 till 31/12 2000	Lars-Erik Holm	73/187/99	1999-11-25	5
43	Avtal mellan SSI och Sveriges meteorolgiska och hydrologiska institut om deltagande i den nationella strålskyddsberedskapen 1/1 2000 till 31/12 2001	B. Åke Persson	73/362/00	2000-02-21	4
44	Överenskommelse mellan SSI och OKG AB rörande mätverksamhet i samband med nedfall av radioaktiva ämnen	Lars-Erik Holm	856/3245/96	1996-12-12	2
45	Överenskommelse mellan SSI och Barsebäck kärnkraftverk rörande mätverksamhet i samband med nedfall av radioaktiva ämnen	Lars-Erik Holm	856/296/96	1996-01-29	2
46	Överenskommelse mellan SSI och Forsmark kärnkraftverk rörande mätverksamhet i samband med nedfall av radioaktiva ämnen	Lars-Erik Holm	856/297/96	1996-01-29	2
47	Överenskommelse mellan SSI och Ringhals kärnkraftverk rörande mätverksamhet i samband med nedfall av radioaktiva ämnen	Lars-Erik Holm	856/298/96	1996-01-29	2
48	ABEM AB, beredskapshållning av radiakinstrument	Jack Valentin	850/86/92	1992-05-04	4
49	Svar från Forsmarks kraftgrupp	Monica Eklöf	FQ-2001-159	2001-02-29	2
50	Svar från Barsebäck	Thomas Åberg	P-200102-71	2001-02-21	2

51	Svar från Umeå universitet	Lennart Johansson		2001-02-28	1
52	Svar från Lunds universitet	Christopher Rääf		2001-03-06	4
53	Mantimmar I laboratorier (cf. n:r 14)	Rolf Falk	Klassifisering.xls (5)	2001-03-06	1
54	Radonkalibreringar	Nils Hagberg		2001-01-25	8
55	Slutrapport (Konsultuppdrag inom laboratorieverksamhet…)	Bertil Persson, Elis Holm		1982-02-01	11
56	Laboratorieverksamhet	Rolf Falk?			2
57	Svar fra Afd. Radiofysik, IMV, Linköping	Håkan Petterson		2001-03-27	3
58	Svar fra SLU, Uppsala	Klas Rosén		2001-03-06	4
59	Svar fra Göteborg Universitet	Mats Isaksson		2001-03-09	4
60	Svar fra Ringhals AB	Dan Aronsson		2001-03-07	1
61	Nationellt program för miljöövervakning av radioaktiva ämnen	Lynn Hubbard			1
62	Commission Recommendation of 8 June 2000 on the application of Article 36 --	For EU, Margot Wallström	C(2000) 1299	2000-07-27	9
63	Finansiering av strålskyddsforskning i Sverige	Ulf Bäverstam		2001-05-16	1
64	SSI:s fältgammaverksamhet	Hans Mellander		2001-05-18	1
65	Fysiklaboratoriet	Hans Mellander		2001-05-18	1
66	Kemilaboratoriet	Lena Wallberg		2001-05-21	2
67	GIS-lab	Jonas Lindgren		2001-05-18	1

SSI-rapporter 2001

SSI reports 2001

2001:01 Patientdoser från röntgenundersökningar i Sverige – sammanställning av resultaten från sjukvårdens rapportering 1999
Avdelningen för personal- och patientstrålskydd.
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