Ds 2004:44

SWEDEN'S THIRD NATIONAL REPORT UNDER THE

Convention on Nuclear Safety

Swedish implementation of
the obligations of the Convention

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REGERINGSKANSLIET
Ministry of the Environment

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Foreword

This report is issued according to Article 5 of the Convention on Nuclear Safety. Sweden signed the Convention on September 20, 1994, the first day it was open for signing, during the ongoing General Conference at IAEA. The Convention was ratified about a year later, on September 11, 1995 and it entered into force on October 24, 1996.

The first national report on the Swedish implementation of the obligations under the Convention was issued in August 1998. As a self-assessment Sweden complied with the all the obligations. The report was well received at the first review meeting 13-23 April 1999 at IAEA in Vienna.

The second national report was issued in August 2001. Also this report was well received at the second review meeting 15-26 April 2002.

During the period before the second review meeting, Sweden received in total 77 questions on the report from ten countries, which were relatively few questions to a country with such a large nuclear power programme. The questions were mostly requests for clarifications and minor additions, touching on many different subject areas.

During the discussion at the review meeting it was agreed that Sweden seems to comply well with the obligations. Especially it was noted that the Swedish regulatory system is well developed with a clear legislation, basic regulations and quality assurance of the regulatory processes. The strong emphasis on the licensee's own responsibility for safety, and the legal possibilities for the regulatory body to focus its supervision on the most important issues for safety, attracted great interest. Also the ongoing work by SKI to issue "back-fitting" guidelines for the existing reactors was discussed with great interest, and the group wanted Sweden to report on the outcome of this work at the next review meeting. Furthermore, the Swedish experience of deregulation of the electricity market was discussed. The group took note of the SKI practice to review ownership changes and major organisational changes in the industry, and concluded that the Swedish regulations are strong with regard to requirements on safety management. Finally the review meeting took note of the agreement between SKI and the nuclear industry to finance basic resources at the technical universities for nuclear teaching and research. Sweden was commended for this initiative that was considered good practice for countries having decided to terminate their nuclear programmes and being concerned over the future supply of nuclear experts. However, also long-term measures along this line may be needed.

Sweden accepted to report especially on the following issues in its next report:

- the continued development of methods to assess organisational change from the safety point of view, and results gained from such review,
- consequences of the application of the new "back-fitting" guidelines on the fleet of reactors,
- long-term measures to safeguard the supply of nuclear experts.

As was the case with the two earlier reports, a four persons working group with one representative each from the Nuclear Power Inspectorate, the Radiation Protection Authority, Vattenfall AB and Sydkraft AB has produced the present report. The Nuclear Power Inspectorate was assigned the task to co-ordinate the work.

The present report has the same structure as the two earlier reports. For the first time in this context Sweden also reports about the two research reactors at the Studsvik site.

The general conclusions about the Swedish compliance with the obligation of the Convention are reported in the executive summary.

List of abbreviations

ALARA	As Low As Reasonable Achievable (a principle applied in radiation protection)
ANS	American Nuclear Society
ASAR	As operated Safety Analysis Report
BAT	Best Avaliable Technology
BKAB	Barsebäck Kraft AB
BSS	The Basic Safety Standards Directive of the Euratom
BWR	Boiling Water Reactor
CTH	Chalmers Tekniska Högskola (Chalmers Institute of Tecnology)
EPRI	Electric Power Research Institute
EUR	European Utility Requirements
FKA	Forsmarks Kraftgrupp AB
FSAR	Final Safety Analysis Report
GDC	General Design Criteria
HWC	Hydrogen Water Chemistry
I&C	Instrumentation and Control
IGSCC	Inter Granular Stress Corrosion Cracking
INES	The IAEA/NEA International Nuclear Event Scale
KSU	KärnkraftSäkerhet och Utbildning AB (the Swedish Nuclear Training and Safety Center)
KTH	Kungliga Tekniska Högskolan (Royal Institute of Technology)
LER	Licensee Event Report
LWR	Light Water Reactor
MTO	Interaction between Man-Technology and Organization
NDT	Non Destructive Testing
NEA	Nuclear Energy Agency within the OECD

NKS	Nordisk kärnsäkerhetsforskning (Nordic Safety Research Project)
NPP	Nuclear Power Plant (including all nuclear power units at one site)
NUREG	Nuclear Regulatory Guide (issued by the USNRC)
PSA	Probabilistic Safety Analysis (or Assessment)
PWR	Pressurized Water Reactor
QA	Quality Assurance
RCM	Reliability Centred Maintenence
R&D	Research and Development
SAR	Safety Analysis Report
SKB	Svensk kärnbränslehantering AB
SKI	Statens kärnkraftinspektion (Swedish Nuclear Power Inspectorate)
SKIFS	Statens kärnkraftinspektions författningssamling (the SKI Code of Regulations)
SSI	Statens strålskyddsinstitut (Swedish Radiation Protection Institute)
STF	Säkerhetstekniska föreskrifter (Technical Specifications)
USNRC	US Nuclear Regulatory Commission
WANO	World Association of Nuclear Operators
SWEDAC	Swedish Board for Accreditation and Conformity Assessment
WENRA	Western European Nuclear Regulators Association

EXECUTIVE SUMMARY: GENERAL CONCLUSIONS

The national reports to the review meetings according to Article 5 of the Convention call for a self-assessment of each Contracting Party with regard to compliance with the obligations of the Convention. For Sweden this self-assessment has demonstrated full compliance with all the obligations of the Convention, as shown in detail in part B of this national report.

Sweden wishes to emphasise the incentive character of the Convention. In the opinion of Sweden, the Convention implies a commitment to continuous learning from experience and a proactive approach to safety improvement. Therefore, Sweden has found it important that a National Report highlights strong features in national nuclear practices as well as areas where special attention to the further development is needed. Improvement measures in those areas should be implemented when needed and be followed up in the national reports to subsequent review meetings.

During the last years the nuclear power operating environment has become more stable in Sweden. The licensees have adopted to the deregulated electricity market situation, and there is again a longterm planning for the continued investments in the nuclear power plants. Efforts are going on to remove the political uncertainty of future operations. SKI is in the process of issuing new regulations on design and construction of nuclear power reactors, for their continued modernisation and safety upgrading.

During the last years, there have also been challenges for the safety work of the licensees as well as for the regulatory bodies, demonstrating the continious importance of a strong preventive safety work.

The generally positive impression reported to the first and second review meetings under the Convention still stands. Therefore, Sweden would like to point out the following as strong features in its national nuclear practice:

- The Swedish legal framework is well developed and the responsibility for safety is very well defined.

- There is an open and constructive dialogue between the regulatory bodies and the licensees.

- The owner companies are well established with good corporate financial records. They demonstrate a commitment to maintain a high level of safety in their nuclear power plants.

- Not withstanding the increased competition, the licensees continue to co-operate in solving important safety issues.

- The regulators in Sweden are assessed as well qualified for their tasks and their resources have been maintained. The international co-operation networks of both regulators and utilities are well developed.

From the safety and environmental impact point of view, the Swedish nuclear power plants are competitive internationally. However, Sweden would like to point out the following issues, where further development should be given special attention in relation to the obligations under the Convention:

- The compatibility of the Act on Nuclear Activities with the Environmental Code needs to be followed up in order to assure that the licencing process is fully consistent.

- The future supply of radiation protection specialists needs to be further investigated and measures may need to be taken, as has been done to ensure the supply of nuclear safety specialists.

- The ongoing concentration of vendors and service companies needs to be assessed, from the safety and availability point of view, and the licensees may need to implement their own joint solutions if the market can not supply the necessary services at acceptable conditions.

- The operating organisations need to assess their consolidation after several organisational changes following deregulation, in order to verify that preventive safety work, such as operating experience feedback analysis and its implementation at the plant level, has the necessary strength.

- Events occurred during 2003 show that licensees need to implement a stronger internal assessment of their safety management.

- A good planning needs to be implemented, by the licensees as well as the regulatory bodies, in order to deal with management of ageing as well as modernisation and upgrading of the nuclear power plants.

- The licensees need to closely monitor their efforts to transfer knowledge from key staff soon being retired, with experience from the beginning of the Swedish nuclear programme, to younger generations of engineers and other specialists.

Sweden is looking forward to reporting on the development regarding the above issues in its 2008 national report to the Convention.

At the second review meeting in April 2002, Sweden accepted to report on the following issues in particular, in its 2005 report:

1. The continued development of methods to assess organisational change from the safety point of view, and results gained from such review
2. Consequences of the application of the new ”back-fitting” guidelines on the fleet of reactors,
3. Long-term measures to safeguard the supply of nuclear experts

These reports can be found in the following sections of part B:

1. section 12.4
2. section 18.2
3. sections 6.4 and 11.5

These reports do not indicate any concerns as to the Swedish compliance with the obligations under the Convention.

A. INTRODUCTION

1. Current role of Nuclear Power in Swedish Power Production

The electrical power consumption in Sweden was about 145 TWh in 2003 as compared to 150 TWh in year 2000 and 143 TWh in 1998[1]. The total electrical power production was 132 TWh, which means that Sweden had to rely on some imports. The 2003 nuclear power production was about 66 TWh, a rather normal share. The 2003 hydropower production was 53 TWh, which is much less than normal. Wind power production was 600 GWh, a steady increase over the last years. Fossil based power production was about 14 TWh, that is more than normal depending on the low hydropower availability. In a normal year the production shares of hydropower and nuclear power are about equal. During the latest years the availability of hydropower has decreased due to dry weather conditions.

Since 1996 the electrical power market has been deregulated and is competitive in principle for both the production and sale of electricity. The national high voltage grid is managed by a state authority: Svenska Kraftnät. Regional and local grids are operated by various grid companies as regulated monopolies. A Nordic marketplace Nord Pool has been created for the electricity trade. Spot market prises have fluctuated considerably during the operational period of Nord Pool. The first years after deregulation prices fell to very low levels but the last years prices have been higher and more stable, one reason beeing the reduced hydropower output.

2. Development of Nuclear Power in Sweden

In Sweden, nuclear technology started in 1947, when AB Atomenergi was constituted to carry out a development programme decided by the Parliament. As a result, the first research reactor went critical in 1954. This was followed by the first prototype nuclear power plant Ågesta, which was mainly used for district heating and operated from 1964 until 1974, when it was finally shut down. The first commercial nuclear power plant Oskarshamn 1 was started in 1972 and was followed by another 11 units in the time period up to 1985. The twelve commercial reactors constructed in Sweden comprise 9 BWRs (ASEA-ATOM design) and 3 PWRs (Westinghouse design).

One commercial reactor, Barsebäck 1, has been finally shut down. The earlier time limit 2010 set for decommissioning of the remaining units has been abolished.

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[1] According to the activity report 2003 from organisation "Swedish Energy". The figure is corrected for the average outside temperature.

3. Political development of the Nuclear Power Issue

As described in detail in the first national report to the Convention, nuclear power has been a very prominent issue in the political debate in Sweden since the 1970's. In 1997, an Act on the phase-out of nuclear power was decided in Parliament. This Act authorises the Government to shut down a nuclear power reactor as a consequence of conversion of the energy system. The location, age, design and importance for the energy system of a particular reactor shall be considered when taking such a decision. The Act also includes provisions for reimbursement of the reactor owner, in the case a shut down decision is taken according to the Act.

Based on the new act, Barsebäck 1 was shut down in the end of November 1999. Parliament has decided that a condition for also closing down Barsebäck 2 is that the electricity production loss can be compensated through the addition of new electricity production, as well as through decreased use of electricity. In June 2003, parliament found that this condition would not be fulfilled before the end of 2003. In 2002 the Government appointed a special investigator in order to explore the possibility of an agreement with the reactor owners on a long-term and sustainable policy for the phase out of nuclear power and the continued realignment of the energy system. Since 2003, the shut down of Barsebäck 2 is being considered in the context of this agreement.

4. Nuclear Power Installations in Sweden

At present, in May 2004, there are 11 nuclear power reactors in operation in Sweden as specified in Table 1. Two power reactors are permanently shut down, namely Ågesta and Barsebäck 1. In addition to the power reactors, two research or multi purpose reactors are in operation at the Studsvik site. All the BWRs were designed by the domestic vendor ASEA-ATOM (later ABB Atom, now Westinghouse Electric Sweden AB) and all the PWRs, except Ågesta, by Westinghouse USA.

The Swedish power reactors represent seven design generations, five for BWR and two for PWR. They are mainly designed according to US 10CFR 50 Appendix A: General Design Criteria and US industrial standards existing at the time. The Swedish designer added some specific features, advanced for the time, and the state utility Vattenfall made some further modifications of the reactors ordered for Ringhals. After commissioning, all reactors have undergone a large number of modifications and safety improvements over the years, but with exception of Oskarshamn 1 the basic designs have not been changed. Oskarshamn 1 has been extensively upgraded 1995-2002 to comply with modern safety standards.

Eight of the power reactors have been uprated between 6-10 % from the original licensed power level. These upratings made 1982-1989 were possible due to better use of existing margins, better methods of analysis and improved fuel design. The licensees have recently announced further plans for uprating and applications have been submitted for Ringhals 1, Ringhals 3 and Oskarshamn 3.

The R2 reactor in Studsvik was designed by American Car & Foundry, main vendor was Allis Chalmers. The original concept was a research reactor, now decommissioned, at Oak Ridge National Laboratory in USA. Similar reactors as R2 exist today at Pelindaba in South Africa and at Petten in the Netherlands. The

Name	Licensed thermal power level MW[2]	Electrical gross output MW	Type	Operator	Construction start	Commercial operation
Ågesta	105	12	PHWR	AB Atomenergi Vattenfall	1957	1964[3]
Barsebäck 1	1800	615	BWR	Barsebäck	1970	1975[4]
Barsebäck 2	1800	615	BWR	Kraft AB	1972	1977
Forsmark 1	2928	1006	BWR	Forsmarks	1971	1980
Forsmark 2	2928	1007	BWR	Kraftgrupp AB	1975	1981
Forsmark 3	3300	1200	BWR		1978	1985
Oskarshamn 1	1375	465	BWR	OKG Aktiebolag	1966	1972
Oskarshamn 2	1800	630	BWR		1969	1975
Oskarshamn 3	3300	1200	BWR		1980	1985
Ringhals 1	2500	860	BWR	Ringhals AB	1968	1976
Ringhals 2	2660	910	PWR		1969	1975
Ringhals 3	2783	960	PWR		1972	1981
Ringhals 4	2783	960	PWR		1973	1983
Studsvik R2*	50	-	MPR	Studsvik Nuclear AB	1958	1961
Studsvik R2-0*	1	-	MPR	Studsvik Nuclear AB	1958	1961

Table 1. Nuclear power installations and research reactors in Sweden. Main data. *) Research reactors

R2-0 reactor was designed and constructed by ASEA-ATOM.

The two Studsvik reactors use to a great extent common systems and are located in the same pool. The reactors have been extensively modified over the years. They are mainly used for commercial materials testing purposes, isotope production as neutron source for research purposes, for medical applications and higher education. Section 6.5 provides an overview of the main current safety issues for these reactors.

Ownership, organisation and staffing

The last year's restructuring of the European nuclear power industry, caused by the deregulation and widening of the electrical power markets, has brought about an internationalisation of the two dominant Swedish utilities: Vattenfall AB and Sydkraft AB. Vattenfall AB has acquired large power production assets in Poland and

[2] According to SKI documentation.
[3] Decommissioned in 1974 and now slightly maintained by Vattenfall AB and AB SVAFO. All fuel and heavy water as well as parts of the primary system (some of the steam generators) have been removed from the installation.
[4] Shut down on November 30 1999 according to governmental decision.

Germany, including co-ownership of four German nuclear power plants, and is establishing itself as a major actor on the European level. For Sydkraft AB, one of the German utilities, E.ON, has acquired a majority of the shares. The Norwegian utility Statkraft has acquired another big part of Sydkraft. The Finnish utility Fortum, owner of the Loviisa nuclear power plant, has established as a big owner on the Swedish market, with a large share of OKG Aktiebolag. The result is a large extent of cross ownership of the Swedish nuclear power operating organisations as shown in figure 1 below.

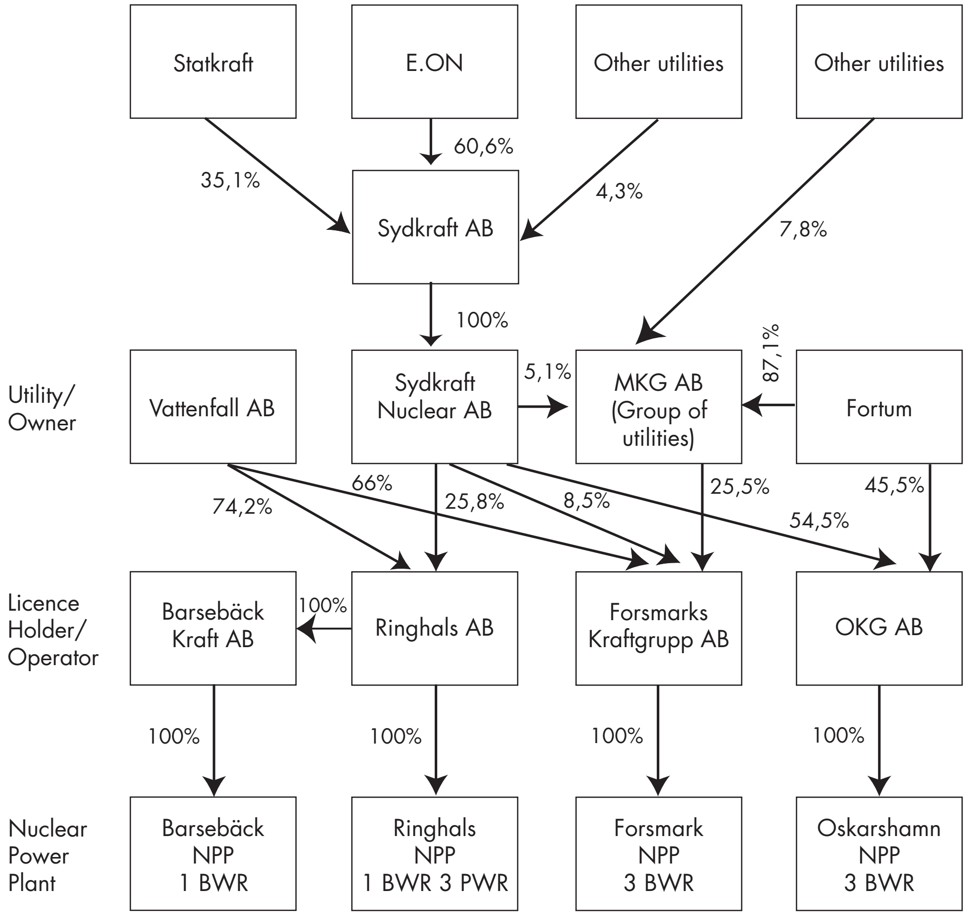

Figure 1. Utility structure and owner relations

The staff figures for the different sites compared with those in the first and second reports to the Convention are:

NPP	Staff 1998	Staff 2001	Staff 2003
Barsebäck	430	360	344
Forsmark, incl. SFR	850	740	794
Oskarshamn, incl. CLAB	1050	900	837
Ringhals	1200	1080	1162

Table 2: Staffing of the Swedish NPPs 1998, 2001 and 2003

As can be seen, the staff reductions between 1998 and 2001 have been reversed for Forsmark and Ringhals as the organisations have been consolidated after a period of rationalisation and outsourcing as a result of deregulation. This consolidation has included employing of new specialists and some earlier contractors as full time staff members. The closure of Barsebäck 1 and the agreement with Ringhals to provide services for Barsebäck 2 has continued to reduce staffing in Barsebäck. The number for Barsebäck in the table above includes people that are today employed by Ringhals but working at the Barsebäck plant. Section B 11.3 provides more details about the current staffing situation.

Own support organisations

The Swedish nuclear power plant operators jointly own the following support organisations:

- KSU AB (Nuclear Safety and Training): provides operational training, including simulator training, on a contracting basis for all Swedish nuclear power plants. KSU also analyses international operational experience and provides the results to the Swedish operators. In addition KSU publishes regular reports about operational experience from Sweden and provides other information about nuclear power to politicians and decision makers.
- SQC AB (Swedish Qualification Centre): a company for independent qualification of NDT systems to be used by NDT-companies in Swedish nuclear power plants.
- ERFATOM: a co-operation between the Swedish and Finnish BWR operators and Westinghouse Electric AB (former ABB Atom) to carry out experience feedback analysis of events at Swedish BWRs.
- SKB AB: a company for dealing with spent nuclear fuel and radioactive waste. SKB owns the intermediate storage of spent fuel CLAB in Oskarshamn and the final storage for low and medium level waste SFR in Forsmark. SKB is aslo responsible for the R&D-work in connection with the technical concept and location of the final repository for the spent fuel, including the Äspö Hard Rock Laboratory.

Other commercial services in the nuclear power field

The supply of services in the nuclear field has been concentrated to a few companies over the last years. The main Swedish vendor ASEA-ATOM, later ABB Atom, is now owned by the Westinghouse Corporation of the BNFL group under the name Westinghouse Electric Sweden AB. Other active vendors of reactor systems on the Swedish market are Framatome ANP, General Electric and Westinghouse USA.

Regarding different services there are still a number of specialised contractors available with a good knowledge of the Swedish plants. However several of these companies have rather old staff and the market is not regarded as attractive for new actors. An increased competition from abroad can be expected. In Sweden there is no legally required licensing of contractors for normal commercial services, except for NDT-companies where an accreditation by SWEDAC is required and for companys dealing with asbestos. SKI requires the licensees to make the necessary check of quality and competence of a contractor and take full responsibility for the work done by the contractor. This makes it easier for foreign contractors to establish in Sweden.

The Swedish nuclear power plant licensees have noticed that is has become more difficult to recieve tenders for maintenance work, since fewer companies are bidding. One possible solution in the future, discussed among the Swedish licensees, is to go together and establish joint companies, if the market can not provide the necessary services at acceptable conditions (see also section B 11.3).

Studsvik Nuclear AB is still an important contractor for materials testing and nuclear fuel investigations. Studsvik also has many international customers. For the Swedish nuclear power plants, it is an advantage to have a competent domestic company dealing with irradiated materials and fuel investigations, since it is not uncomplicated to transport such materials over national borders. With a domestic company, investigations can be made faster to the benefit of safety and availability of the plants.

Nuclear waste

The Swedish nuclear power programme, including the Studsvik facilities (research reactors, hot-cell and waste treatment facilities) and the Westinghouse Electric Sweden AB fuel fabrication plant in Västerås, will generate approximately 19 000 m^3 spent fuel, 60 000 m^3 low and intermediate level waste (LILW), and 160 000 m^3 decommissioning waste (based on 40-year operation of each reactor). The typical total annual production of LILW at the nuclear facilities is 1 000-1 500 m^3.

Existing waste management practices are the repository for radioactive operational waste, SFR-1, shallow land burials, CLAB, the transportation system and clearance.

SFR-1 is a repository for LILW resulting from the operation of Swedish nuclear reactors. In addition small amounts of radioactive waste from hospitals, research institutions and industry are disposed of in SFR-1. SFR-1 consists of four rock caverns and a silo. The facility is situated at 50 m depth, in the bedrock 5 m under the sea level. Construction started in 1983 and it was taken into operation in 1988. The total capacity is 63 000 m^3. By the end of 2003 a total volume of 30 059 m^3 had been used. The nuclear power plants at Ringhals, Forsmark and Oskarshamn as well as the Studsvik site have shallow land burials for short-lived very low-level waste

(< 300 kBq/kg). Each of these burials is licensed for a total activity of 100 GBq (the highest level according to the legislation is 10 TBq, of which a maximum of 10 GBq may consist of alpha-active substances).

The spent nuclear fuel from all Swedish nuclear power reactors is stored in a central interim storage (CLAB) situated at the Oskarshamn nuclear power plant. The fuel is stored in water pools in rock caverns at 25 m depth in the bedrock. Construction started in 1980 and it was taken into operation in 1985. The current total storage capacity is 5 000 tonnes of spent fuel. 4 100 tonnes were being stored at the end of 2003. CLAB is currently being expanded with a second rock cavern and water pool. The capacity after the expansion will be sufficient for storing all spent fuel from the nuclear power reactors, approximately 8 000 tonnes. This expansion will be commissioned at the end of 2004.

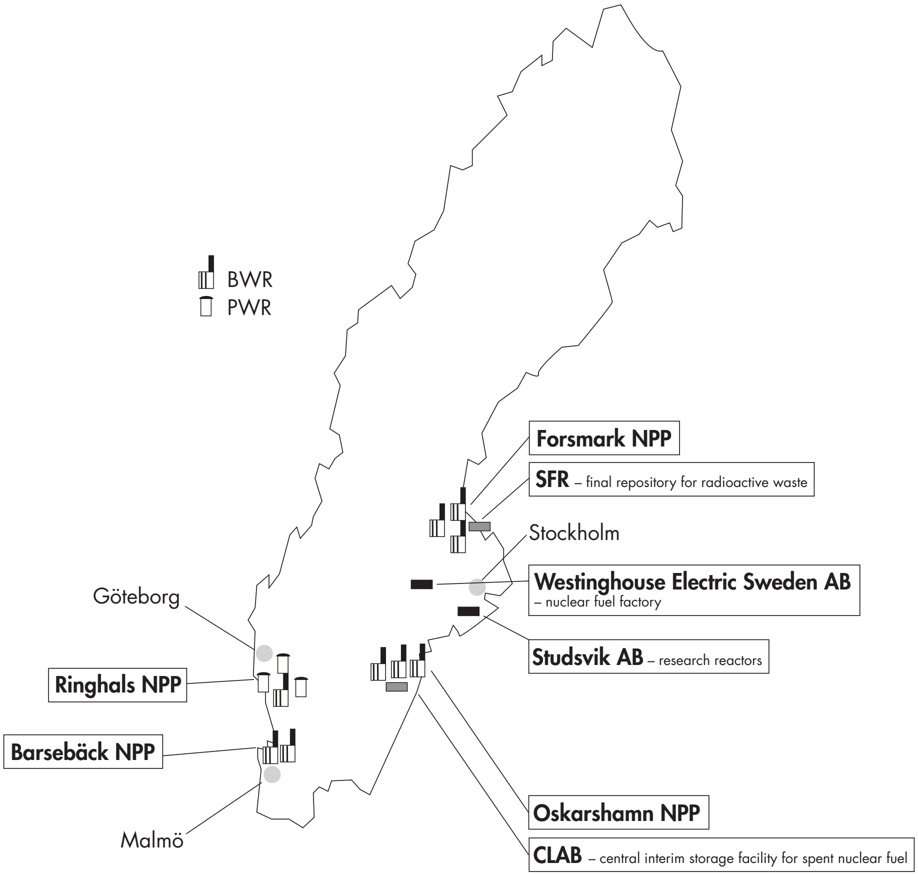

Figure 2. Location of the nuclear facilities in Sweden

All transportation of spent nuclear fuel and nuclear waste is by sea, since all the nuclear facilities are situated at the coast. The transportation system has been in operation since 1982 and consists of the ship M/S Sigyn, transport casks and containers, and terminal vehicles for loading and unloading. Although clearance is not a ”facility” it is an important component in the waste management system. Material may be cleared for unrestricted use or for disposal as conventional non-radioactive waste.

Four major facilities remain to be designed, sited, constructed and licensed. Namely a plant for the encapsulation of spent nuclear fuel, a final repository for spent fuel, a repository for long-lived low and intermediate level waste, and a repository for waste from decommissioning and dismantling the nuclear power plants. The development work for the final respository of spent fuel has continued according to plan and the process for selecting suitable sites is underway. Östhammar, close to Forsmark, and Oskarshamn are presently being investigated as possible locations for the final repository. These investigations are planned to be completed in 2008.

Nuclear education, research and development

As mentioned in the second report to the Convention, the academic education in nuclear technology in Sweden is mainly concentrated to the Royal Institute of Technology in Stockholm (KTH) and Chalmers Institute of Technology in Gothenburg (CTH). At KTH the Swedish Centre of Nuclear Technology (former name Nuclear Technology Centre) has existed since 1992. From having been mainly oriented towards KTH, the Centre has now as its aim also to support doctorate studies, research projects and post-graduate education in the nuclear field at other Swedish universities. Six professorships with a specific nuclear technology profile, two with a human factors profile and eight lectureships exist in Sweden for higher nuclear education and research.

As also mentioned in the second report, Sweden has taken a systematic approach to maintain basic academic resources for higher nuclear education and research. This is done by an agreement between the Swedish nuclear industry and SKI to support the Swedish Centre of Nuclear Technology economically during several years. Reassessment of the needs will be made in 2006. The agreement was reached to mitigate the concerns about less interest in higher academic nuclear education, as a result of the political decision to phase out nuclear power (see further section 11.5).

5. Swedish participation in international activities to enhance nuclear safety and radiation protection

Regulatory bodies

In the first report to the Convention, it was mentioned that representatives from SKI and SSI have traditionally been active in international nuclear co-operation within IAEA, OECD/NEA and EU, as well as in bilateral contexts. An active contribution to these activities is considered to be important for the quality of the national safety and radiation protection work. The co-operation has included regulatory issues as well as research projects, especially in the framework of EU and NEA, and expert missions, especially in the framework of IAEA.

In addition, SKI is a member of the Western European Nuclear Regulators Association (WENRA) and the International Nuclear Regulatory Association (INRA). At present SKI holds the chair of WENRA. An important work within WENRA is to compare safety requirements of the different member countries, against agreed reference levels, as a basis for harmonisation. The final report is expected in 2005. SKI has already used results from this project in the development of its basic safety regulations.

Senior experts of SSI are active participants in, for example, ICRP, the OECD/NEA, IAEA, EU committees and working groups and the UN scientific Committee UNSCEAR. Further the international engagement of SSI is not limited to regulatory issues but also includes participation in international research projects. Most of the projects where SSI is engaged are within the EU research programme, NEA and IAEA. SSI has also actively in the last years been involved in expert missions in the NEA work covering areas like radioactive waste management, radiation protection philosophy, decommissioning issues and environmental radiological protection.

Both SKI and SSI expect that the international participation will require increased resources during the next years as nuclear regulation, while still being a national responsibility, becomes more and more international. Important driving forces here are the enlargement of EU as well as more explicit policies within IAEA and other organisations for development of common safety standards and regulatory practices.

International support programmes

Sweden has continued its technical support and co-operation programme mainly directed at Lithuania and North Western Russia. This programme, which includes reactor safety, waste management, radiation protection and emergency preparedness is administered by the Swedish International Project Nuclear Safety (SIP) and the SSI unit for international support International Development Co-operation (SIUS). Since 1991, Sweden has allocated 551 MSEK for international technical assistance within the designated areas. The appropriation for 2003 is 45 MSEK including 5 MSEK for the support of the decommissioning of Ignalina unit 1. Besides the bilateral co-operation SIP and SIUS are also active in the EU Phare and Tacis programmes.

The Swedish technical support will change somewhat during the coming years. The bilateral programme directed to Lithuania will be phased out in connection with Lithuania's accession to EU on May 1 2004. The remaining support will, to a greater extent, be directed through the Swedish International Development Agency and the EU Phare and Tacis programmes. The bilateral support to North Western Russia and Belarus will however still be maintained some more years.

Utilities

The utilities in Sweden have traditionally also been active in international co-operation to enhance nuclear safety by sharing experience, contributing to work with international regulation and guidelines and participating in safety assessments and peer reviews. This is today primarily accomplished through membership in WANO, in owners group associations of the major European and US vendors, and by participation in the European Utilities Requirements project, IAEA activities, and various task forces representing most of the disciplines in nuclear facilities.

Swedish utilities and authorities have for a long time co-operated in international projects and research organisations. Particular examples are the Nordic Safety Research Project (NKS) – on-going since 1977 – and programmes and projects within EPRI and NRC in the US and OECD and EU in Europe. Common experience of all these projects and organisations is that they have all been adapted to today's needs and conditions and are controlled in a stricter way than was previously the case.

ISOE (Information System on Occupational Exposure) is an example in the field of radiation protection, where Sweden is a member and an active participant on both the utility and regulator side.

European Utility Requirements

Vettenfall has via its subsidiary Forsmark been a member of the European Utility Requirements (EUR) group since the work started in 1991, and is today representing all the Swedish utilities. The EUR generic requirements have undergone detailed reviews by peer utilities worldwide, as well as by vendors and regulators, and the EUR document is now complete. The overall objective for the Swedish participation, as there are no plans for new nuclear power construction in Sweden, is to obtain a basis for further development of safety of the existing plants.

The EUR document today includes all the parts that were foreseen when the work started. Two sets of generic requirements have been developed: one dedicated to LWR nuclear islands the other one to power generation plants. Another volume deals with the application of the EUR generic requirements to those LWR designs that may be offered in Europe. The document has been or is being benchmarked vs. other sets of safety requirements, EPRI-URD, US regulatory requirements, and IAEA requirements & guides. Beside the sets of generic requirements of EUR volume 1 & 2, the EUR promoters have produced evaluations of selected LWR designs that may be offered on the European market. Brought together, they make up volume 3 of the EUR document. The EUR document has also been used as the base in the call for bids of the fifth

Finnish nuclear unit.

The number of participants has increased over the years, and the EUR group in early 2004 involved the following partners: British Energy, Electricité de France, Fortum (Finland), Iberdrola (Spain), Nuclear Research & consultancy Group (Holland), Rosenergoatom (Russia), Società gestione impiante nucleari (Italy), Tractebel (Belgium), Teollisuuden Voima Oy (Finland), Unterausschuss Kernenergie (Switzerland), Vattenfall (Sweden) and Verband der Eletrizitätswirtschaft (Germany).

The EUR organisation also decided to analyse the earlier mentioned WENRA reference levels with regard to the last published issue of the EUR safety requirements, the revision C of volumes 1 and 2. The first results have been presented to WENRA.

B. COMPLIANCE WITH ARTICLES 4 TO 19

4. Article 4: IMPLEMENTING MEASURES

Each Contracting party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

The legislative, regulatory and other measures to fulfil the obligations of the Convention are discussed in this report.

5. Article 5: REPORTING

Each Contracting Party shall submit for review, prior to each meeting referred to in Article 20, a report on the measures it has taken to implement each of the obligations of this Convention.

The present report constitutes the third Swedish report issued in compliance with Article 5.

6. Article 6: EXISTING NUCLEAR INSTALLATIONS

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonable practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

6.1 Overview of major events since the last national report

In their annual reports to the Government for the years 2001-2003[5], SKI and SSI point out that the safety of the Swedish Nuclear Power Plants has been satisfactory in relation to requirements. There were no events indicating a serious degradation of safety, although some events and inspection results showed that there

[5] SKI Reports 02:14, 03:21 and 04:16, SSI Reports 02:07, 03:06 and 04:04 (in Swedish only).

is room for improvement.

Software faults

During 2001, two events were reported where the control rod electronics failed in a reactor because of software faults. The indication of the control rod positions showed not to be reliable and the manual manoeuvre was blocked. In addition it was detected that wrong in-data had been used for the dry-out calculation of SVEA-96 fuel in three reactors. The mentioned events emphasise the need to improve verification of software for safety related systems. Computerised I & C is now installed to a great extent in Swedish plants in connection with upgrades and modernisation. SKI devotes time and resources to address these problems from the regulatory point of view.

Safety culture related events

An INES-2 event was reported 2001 at Barsebäck 2, where a rupture-disc of the containment venting filter system showed to be wrongly fitted. This was a recurrent event indicating deficiencies in the self-inspection system of the licensee.

During 2002/2003 several events occurred showing deficiencies in the safety management of some of the licensees. The most significant event occurred at Barsebäck 2 . Tie-joints with thermal sleeves installed at the 2002 refuelling outage in the feed-water lines loosened under operation and partly blocked the feed-water flow. Flow mismatch between the two lines and pressure differences were detected, but the plant was not stopped for investigation until January 2003. It was then detected that the tie-pins of the sleeves had failed due to feed-water flow induced vibrations. Parts of metal from the sleeves and the support pins were found at the bottom of the reactor pressure vessel, although without any identified fuel cladding damage.

Root cause analysis was performed by the licensee and reviewed by SKI. Weaknesses were found in the decision making process and quality management of the licensee. Safety issues were not timely raised, sufficiently assessed and documented. A lack of questioning attitude existed at several organisational levels. The event was rated INES 1.

The case was also forwarded by SKI to the public prosecutor, in order to obtain a legal judgement whether the management had violated the Act on Nuclear Activities. The prosecutor has initiated an investigation, but not decided yet on bringing the case to the court.

In September 2003, SKI was informed that Oskarshamn 3 had exceeded maximum permissible limits of temperature increase in the reactor pressure vessel. This was a very complicated event occurring in connection with a total grid blackout in the south of Sweden. When the external power supply returned, cold water was fed to the bottom of the reactor pressure vessel. When he main recirculation pumps were restarted after some time, relatively hot water was pumped to the lower part of the vessel causing temperature to increase too much in a too short period of time. The event was classified INES 1. Approval by SKI was needed to restart the reactor after an in-depth technical and human factors investigation. There was no damage to the reactor pressure vessel and the internals according to performed analysis, but follow up inspections will be done during the 2004 outage. Also, the event revealed deficiencies in the feedback of operational experience, the role of the safety department, and the decision making process.

Hydraulic pressure locking and thermal binding of power-operated gate valves is an old and well known safety issue for PWRs. Ringhals has devoted significant efforts for minimising the occurrence and consequence of these phenomena, including a valve verification project of about 700 valves. 71 gate valves in Ringhals 2-4 were found being susceptible to pressure locking and/or thermal binding. The valves belong mostly to the emergency core cooling system (ECCS), containment spray system (CSS) and residual heat removal system (RHRS). A few valves belong to the chemical and volume control system (CVCS). Most of these valves are of the type power-operated gate valve with flexible wedge. A few valves are split wedge gate valves, and two are solid wedge gate valves.

In June 2002, Ringhals 3 experienced for the second time a locking of a gate valve in the RHRS with the unit in hot shutdown, prior to the annual refuelling outage. This valve had earlier not been identified as susceptible of locking phenomena, despite the screening performed through the application of the WOG-screening criteria.

The blocked gate valve did not fulfil the requirements established for accidental conditions. A risk existed, during postulated accidental conditions, for a simultaneous blockage of two redundant valves in the RHRS, thus preventing intended re-alignment of the system for hot leg recirculation.

Structural integrity events

In 2003, Barsebäck 2 and Ringhals 1, which are both BWR, reported water leakage from the containment. Testing and analysis showed that the water originated from the condensation pool. In the Barsebäck case, considerable efforts were made at shut down during the fall to indentify the cause of the leakage. Eventually a leak was found where a ladder was welded to the bottom plate of the condensation pool. The defect weld had caused corrosion. After repair the containment was successfully tested for leakage, without water in wet-well and with water. In the Ringhals case the leakage showed even more complicated. The small leakage was assessed to a defect in the toroid-plate connecting the bottom of the condensation pool with the containment wall. The toroid consists of double plates and the leakage was assumed to the inner of those while the outer was assumed to be tight. Ringhals has not yet (spring 2004) been able to verify the exact location of the leakage. Considerable efforts are going on. The leakage is continuously monitored, verified to be below limits for the containment integrity and the unit is operating.

Other major structural integrity events during the last years have been cracks identified in some nickel base alloy safe end welds of the reactor pressure vessel nozzles at Ringhals 3 and 4. These damages showed to be primary water stress corrosion cracking (PWSCC), not earlier observed in Swedish PWRs. Intensive investigations were made and repairs conducted in both units during outages 2002 and 2003. SKI has very closely reviewed and followed up on these events and also participated in extensive international experience feedback on this damage mechanism, now occurring in PWRs.

Extensive stress corrosion cracking was also observed during outage some years ago in consoles and supports of the emergency core spray systems in Barsebäck 1-2, Oskarshamn 2 and to some extent in Ringhals 1 (all BWRs). Most of the damaged supports were replaced before the units resumed operation. Extensive follow-ups conducted during 2000-2002 showed that some of the remaining cracks had propagated, but no new cracks were identified. The core sprays of Oskarshamn 2 and Ringhals 1 have been completely replaced in 2003 to less sensitive material. SKI has thoroughly reviewed the new designs. In Forsmark 1-2, which are BWRs with internal recirculation pumps, the core sprays have been removed, after presentation of a safety case showing that the systems are not necessary for cooling of the core under design basis conditions. These measures were preceded by extensive analyses and safety review both at Forsmark and at SKI.

Conclusions

Looking back at the events, SKI concludes that it is most important for the licensees to maintain a proactive safety management and an efficient self-inspection, including a high quality of the primary and independent safety review. SKI has concerns that some important safety work, such as experience feedback review and application of relevant international experience, has not received sufficient priority at all plants over the last years. It is also most important that the independent safety review is adequately staffed and has a sufficiently strong influence over the decision making. In the review of the mentioned events, SKI has put strong requirements on the licensee to improve safety management and relevant action has been taken. SKI has also raised these concerns at top management meetings with the licensees. The licensees have responded and concluded that it is time to consolidate the operating organisations, after the early difficult period that followed the deregulation of the electricity market.

Another conclusion that can be drawn from the events is that it is very important for the older plants to address ageing phenomena in a comprehensive and systematic manner. Regarding primary system components this is very well addressed in Sweden, but the containment cases show that attention must also be given other structures of importance for safety. There are different initiatives going on also at the international level to address containment ageing. The issue will be closely monitored by SKI through the upcoming periodic safety reviews. SKI has also reinforced its general safety regulations with regard to ageing management (se section 14.1).

The oldest Swedish reactor Oskarshamn 1 has been extensively upgraded 1995-2002. The licensees are now planning for technical upgrades of the other reactors in order to meet own objectives and the new SKI back-fitting regulations. These initiatives are further described in other chapters of this report.

6.2 Overview of safety assessments performed

Probabilistic Safety Assessments

According to the SKI general safety regulations SKIFS 1998:1, updated as SKIFS 2004:1, all Swedish reactors shall be analysed with probabilistic methods to supplement the basic deterministic safety studies. All power reactors should have complete level 1 and level 2 PSAs including all operating modes and all relevant internal and external hazards for the sites. Today, all power reactors have level 1 and level 2 studies. The level 1 studies have been updated continuously with regard to plant modifications. Work is going on to fill some gaps in the level 1 studies and to finalise studies for low effect, area events and external hazards. According to SKI judgement all missing studies will be developed and submitted within a two-year period. The current situation is summarised in the simplified table below.

Plant	Level 1	Level 2	Fire, Flooding	Low power, Refuelling	Start up- and shut down	External events
Barsebäck 2	2003	2003	2003 [1)]	2003 [1)]	2003	[2)]
Forsmark 1 and 2	2000 [2)]	2000 [2)]	1999 [2)]	1999 [2)]	1999 (down) [2)]	Limited study [2)]
Forsmark 3	1998 [3)]	1998 [3)]	1995 (limited) [3)]	1995 (limited) [3)]	1995 [3)]	[2)]
Oskarshamn 1	2003	1998 [1)]	2003	1999 [2)]	2003 [2)]	[1)]
Oskarshamn 2	2002	2002 [3)]	2003	[2)]	[1)]	[1)]
Oskarshamn 3	2003 [1)]	1998 [1)]	2003	[1)]	[1)]	[2)]
Ringhals 1	2002 [1)]	1996 [2)]	2002 [3)]	1996 [1)]	[1)]	[1)]
Ringhals 2	1992 [1)]	1994 [1)]	1994 [1)]	1998 [1)]	1999 [1)]	[1)]
Ringhals 3 and 4	1992 [1)]	[1)]	1997 [1)]	[1)]	1999 [1)]	[1)]
Studsvik R2, R2-0	2003	-	-	-	-	-

Table 3. Latest PSA versions reported to SKI. Update/or completion planned for [1)] 2004 [2)] 2005 [3)] 2006.

The basic PSA studies are now undergoing a regular updating every year taking into account the past year plant modifications which have impacted the PSA-models. In principle most licensees are moving towards Living PSA.

As mentioned in the first report to the Convention, the numerical PSA figures are not regarded as very important per se in Sweden. There are no requirements related to numerical PSA results, although the licensees have such safety objectives. The studies should be sufficiently detailed, comprehensive and realistic to identify weaknesses in plant configurations and that they can be used to assess plant modifications, modifications of technical specifications and events.

PSA results have been a very important input for the recently completed modernisation of Oskarshamn 1.

Other recent applications have been to improve fire protection at Barsebäck 2 and Oskarshamn 2, better protection against external events at the units in Forsmark and new shut down procedures at Ringhals 2. Currently, PSA is also used for risk-informed assessment of testing intervals at Ringhals 2 (the RIVAL-project) and for optimising technical specifications at Barsebäck 2.

Design basis reassessments and new SAR concepts

As a consequence of the temporary shut down of the five oldest BWR reactors in 1992 and 1993, to improve the emergency core cooling systems, the utilities initiated major reassessments of the final safety analysis reports for their older reactors. The reassessments started with pilot projects in 1993/94 and were scheduled for completion before 2000. The objectives have been

- to develop modern safety reports (SAR) for all units and to verify the basis for the reports,
- to identify and present any deficiencies in safety, so that corrective measures can be taken by the operating organisations,
- to recommend further measures, taking into account the recent international development in relevant safety requirements and practices.

The Swedish design basis reconstitution projects were described in the first report to the Convention. Considerable work has been performed, especially for the older reactors, and it has been necessary to extend the time schedules. The current situation for those projects is:

BOKA For Barsebäck 2 and Oskarshamn 2. The project was completed in 1998 and identified 1 100 open issues. 90 % of these have been resolved, but some of the remaining issues will be coordinated with future modernisation projects. All but one of the deficiencies classified ”significant” will have been taken care of during 2004. The remaining issue deals with environmental qualification of equipment outside of the containment. BOKA only analysed power operation. A follow-up project considering other modes of operation is underway and planned to be completed during 2004. The safety reports have been updated.

REDA For Ringhals 1. This project was completed in 1998, and resulted in more than 1 200 open issues, of which 90 % have been resolved so far. On-going modernisation projects will handle the remaining open issues. The safety report has been updated.

RAK For Forsmark 1 and 2. The project was completed in 2002. The result is some 180 reports that identify how the design basis requirements are met on a general level, and as functional requirements, which in turn set requirements on systems level. The reports also verify that those requirements are fulfilled, or describes how to accomplish that. The final report is not yet been submitted to

SKI. Updated safety reports are planned to be submitted 2004.

KOFOT For Forsmark 3 and Oskarshamn 3. FOKA, a design reconstitution project of certain mechanical equipment has been completed. KOFOT is a broader approach, similar to the reconstitution projects for the older BWRs. Forsmark 3 and Oskarshamn 3 are due to submit periodic safety reviews in 2005, and a reassessment of the SARs will be done in that context.

DART For Ringhals' PWR units 2, 3 and 4. This project is to be completed in 2004. Identified deviations will be managed in separate projects or directly in the line organisation. The implementation of the new SAR has been initiated. New technical specifications, based on the Westinghouse standard MERITS are currently being implemented and planned to be finished in 2005. A separate new project, coordinated with DART, was initiated in 2001 to formulate the design bases to meet the requirements of SKI regulations 2000:2 regarding certain mechanical equipment (see section 7.2).

The Oskarshamn 1 SAR has aslo been updated after finalisation the extensive modernisation project 2002.

SKI regards the safety reports submitted so far as a substantial improvement of the safety documentation and a better verification of the design basis. The design weaknesses identified have been well addressed and measures have been taken or are under way. Evaluation of the designs against new knowledge, requirements and practices has been done only to a limited extent. In the revised safety regulations, SKI has extended the requirements on the SARs and requires a more systematic assessment towards new requirements, standards and practices in the framework of the periodic safety reviews (see articles 7 and 14).

Periodic safety reviews

As mentioned in the first report to the Convention, the Swedish licensees are required to submit a periodic safety review of every reactor unit every 10 years (in Sweden called ASAR: As Operating Safety Analysis Report). The methodology is not specified in the requirements. However it must be consistent and documented. The review should be based on the safety report (SAR), analyses of the latest 10 years of technical and organisational experience and assessments of the safety improvement measures taken during this period. The safety of the unit should be assessed against the licensing requirements as well as against current requirements and practices. Conclusions should be drawn about the current safety level and needs for improvement, as a result of the review.

The periodic safety reviews are submitted to SKI, which makes a comprehensive review and assessment of the submitted report and its references. This regulatory assessment is submitted to the Government. In its regulatory review, SKI uses all the material available from inspections and assessments of the reactor during the 10 year period.

The first cycle of periodic safety reviews is completed for all reactors. The second is almost completed. The current status of the programme is shown in table 4 below.

Reactor unit	Licensee report completed	SKI review report completed
Oskarshamn 1	2004 (third)	2004
Barsebäck 2	1995 (second)	1996
Ringhals 2	2004 (third)	ongoing
Oskarshamn 3	1996 (first)	1997
Forsmark 3	1997 (first)	1998
Ringhals 1	1996/99 (second)	2000
Oskarshamn 2	1999 (second)	2004
Forsmark 1 and 2	2001 (second)	2003
Ringhals 3 and 4	2002 (second)	2004

Table 4. Latest versions of periodic safety reviews.

In general, the regulatory reviews of the ASAR reports have supported the safety improvement programmes adopted by the licensees. In addition, the regulatory bodies have typically issued a number of recommendations. However, to date no periodic safety review has resulted in a questioning of the operating permit of the unit.

SKI has recently revised its regulations about the ASAR making it a more stringent assessment of the safety case against the licensing requirements and relevant new safety standards. This brings the concept closer to the international application of Periodic Safety Review, often used for relicensing.

In the 1980´s, the Government decided that Forsmark 3, Oskarshamn 3, Barsebäck 2, Forsmark 1 and 2 and Ringhals 3 and 4 shall undergo a specific safety assessment before the end of 2010. Originally the intention was to limit the licences in time for these reactors. However, after a verdict by the Swedish highest administrative court (Regeringsrätten), the decisions by the Government should be regarded as licensing conditions, implying that the safety cases of these reactors shall be reassessed 2010. This means that specific safety assessments have to be made, but if the reactors comply with all applicable safety requirements their operation can not be discontinued. SKI will use the new more strict ASAR-concept for making these specific assessments 2010, and present the results to the Government for their decision. This means that some adaptation in time needs to be done for submittal of reports by the licensees. After 2010 SKI will go back to the original schedule for ASAR, using the new more strict concept.

6.3 Reactor modernisation programmes

As mentioned in section A 2 there are seven design generations of reactors in operation in Sweden. These designs were made in the sixties and the seventies. The first reactor, Oskarshamn 1 was commissioned in 1972 and the last ones, Oskarshamn 3 and Forsmark 3, in 1985.

In the earlier two reports to the Convention, is was mentioned that significant upgrading measures had already been implemented in the older units, and that further extensive modernisation was foreseen for all the Swedish units, with exception of the two newest. The modernisation programmes were described in the second report. Below follows an update on the developments during the last three years. In addition, the licensees are currently planning for measures in order to comply with the new SKI regulations (SKIFS 2004:2) on Design and Construction of nuclear power reactors (see further article 18).

Barsebäck 2

- The two sets of diesel-generators from the permanently shut down unit 1 have been arranged to serve as power back up for unit 2
- A new system has been installed for evacuation of gases built up in reactor vessel and containment during severe accidents
- A new scram condition has been added to the reactor protection system

Forsmark 1, 2 and 3

For the current and future modernisation of the plant, a strategy and modernisation plan has been adopted (Program P40+). The programme is to ensure plant safety and technical status, and thereby retain the option for operation for 40 years or more. 70 % of the 40+ program investments are aimed at maintaining technical status, 20 % for safety upgrades and 10 % for dose reduction and environmental improvements. The programme was initiated in 2000 and investment decisions are taken annually. Up to 2003, investments for about 360 MSEK have been committed.

During the period since the previous national report the following major measures have been implemented:

- Removal of the core spray nozzles in the reactor vessel (2003/2004) after analyses showing that all safety requirements are met with injection only. The advantages are: less non-destructive testing will be required in the future, releasing resources for other safety work; avoiding the risk for costly repairs; and lower doses to the personnel.
- Core grids and other reactor internals have been replaced in units 1 and 2, also to reduce the need for future non-destructive testing
- Replacement of equipment in the main circulation pumps to reduce transients on the fuel at loss of external power
- Prevention of oxy-hydrogen in steam systems
- New equipment for physical protection

- Improved fire safety and security systems

Oskarshamn 1

For the oldest unit, Oskarshamn 1, the extensive modernisation programme was completed in 2002. The programme included:

- A new safety concept based on the safety requirements for modern nuclear power plants
- New and modernised systems for performing safety functions
- A modified concept for the reactor protection system, and safety I&C, including a new emergency control room
- A modified concept for electrical power supply
- A new fully separated emergency control building, as well as some modifications to existing buildings

Oskarshamn 2

Examples of measures taken recently are:

- Replacement of piping, penetrations and valves in the primary systems within the reactor containment
- Replacement of reactor internals, i.e. steam separators, and core spray nozzles and piping
- Changes in the reactor protection system including addition of a new condition for reactor scram
- Improvements of some fire protection systems
- Improvements to reduce risks for hydrogen explosions in piping systems

Oskarshamn 3

See section 18.2.

Ringhals 1-4

One extensive plant renewal programme was initiated in 1997 and completed in 2001. During the time period since the previous national report, the following major modernisation projects have been implemented.

Common for all four units:

- Fire system modernisation. The first phase, replacement of fire water pumps for units 1 and 2 is completed.
- Analyses and modifications of safety related valves. Reports for motor operated valves are currently under review, and the work now concentrates on other types, i.e. pneumatically operated valves. Some valves have been given high priority due to recent operating experience, see section 6.1.
- Qualification of equipment outside the containment

Common for the PWRs (units 2, 3 and 4):

- Measures to cope with containment sump blockage during design basis accidents
- Improved battery capacity during station black-out
- Securing of piping for the pressurizer. The project also includes replacement of pressurizer relief valves (PORVs) to environmentally qualified types.

Common for units 3 and 4:

- Replacement of reactor vessel heads, planned for 2004 (unit 4) and 2005 (unit 3)

Ringhals 1

- The RPS project, aiming at the resolution of separation problems between A- and B side of the plant, to meet modern requirements on separation, i.e. for fire events
- Replacement of reactor vessel internal components
- Various measures to cope with dynamic effects in case of high energy line breaks

Ringhals 2

- The TWICE project that involves replacement of instrumentation and control equipment, including the main control room. The final implementation has been delayed and is now planned for 2006.

6.4 Government investigation of nuclear safety

In 2002 the Government appointed a special investigator to analyse the conditions for safety and radiation protection at the Swedish nuclear power plants, taking into account new external circumstances for the nuclear power production. The investigator was expected to study the situation for the licensees and the regulatory bodies, especially with regard to resources and competence. The analysis should cover technical development, ageing of reactors, experience from operations and decommissioning, development of the electricity market, new ways of co-operation between the utilities and new risks for terrorist attack. A special investigation issue was the organisation of the regulatory supervision.

The investigation was not decided because of any specific nuclear events, but for general reasons such as deregulation of the electricity market, the starting of decommissioning by the shut down of Barsebäck 1 and the new security situation after 11 September 2001.

The investigation report[7] was handed over to the minister of environment in November 2003. It was concluded that deregulation initially put the utilities under hard economical pressure. This made them increase availability and lower production costs in a way that could affect safety and radiation protection. However, it was not possible from an economical analysis to prove that safety and radiation protection received less priority even if it is clear that utility managements, earlier technically oriented, now have turned to become more market oriented. The market orientation is judged to be a lasting effect that will put more pressure on the regulators. This will be even more evident as reactors get older and technical upgrading more clearly needed.

The investigator could not find any technical factors, which could threaten safety and radiation protection, on the condition that the regulatory bodies continue their active supervision. Important regulatory challenges mentioned are change to digital I & C and use of risk-informed optimisations. It is concluded that SKI and SSI will have to face a heavy workload the coming years if the licensees will pursue their modernisation plans and applications for up-rating.

The importance of a good safety culture is emphasised and a concern raised that the openness to report mistakes and deviations from regulations can be affected negatively if also minor deviations have to be reported by SKI to a public prosecutor. A minor modification of the nuclear law is proposed to address this. Several issues in connection with the future decommissioning was raised, such as handling of staff motivation, the risks for increasing turnover rates and decreasing safety investments. Regarding new security threats, the investigator concludes that based on the assessments made no major modifications to the reactor designs are needed. The design basis threat has been modified and new physical protection regulations are underway with some stricter requirements on access control. Regular emergency exercises with mixed scenarios are conducted at the nuclear power plants. The investigator concludes that these exercises are well evaluated but the follow up of necessary improvement measures should be improved and reported to the Government.

A specific task for the investigator was to review the supply and demand for nuclear expertise, taking into account the start of decommissioning and the fact that the market for vendors and service companies has narrowed. In 1990 another Government investigation predicted some problems with the supply of nuclear

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[7] Nuclear Safety and Radiation Protection at the Nuclear Power Plants. SOU 2003:100 (in Swedish only).

specialists in connection with the start of decommissioning. This has not proven true. The present investigator found that the nuclear industry does not foresee any problem to recruit the necessary qualified staff. Should narrow specialists disappear from the Swedish market, replacement can be found abroad if needed. All nuclear power plants use strategic personnel planning in order to identify their recruitment needs in good time.

For the regulatory bodies SKI and SSI the situation is similar. They do not foresee any real problems to recruit qualified staff, even if SSI has experienced problems in finding some specialists.

The investigator judges that agreements in place between SKI and the industry to support Swedish Center of Nuclear Technology (SKC) and the universities (se further sections A4 and article 11) will be sufficient for the next ten years to cover the national demands for key nuclear competence. In the longer perspective as more reactors are decommissioned and more approaching their technical end of life, there are reasons to closely monitor the situation.

The investigator shows more concerns about the situation in radiation protection, where higher education and research has decreased over the last years. An increased number of adequately qualified radiation protection specialists will be needed as the nuclear power plants enter their decommissioning phase. There is however still time to improve the situation. It is suggested that the Government orders SSI to investigate the long term needs for strategic national radiation protection competence and suggest measures in order to safeguard the necessary supply of specialists.

Research is a precondition for supply of specialists. The investigator finds that the research situation is satisfactory in nuclear safety but not in radiation protection. There are funding difficulties and the limited resources are split between several research groups. SSI will present a proposal for national research strategy in radiation protection and this issue should be considered at the national research political discussions scheduled for 2004.

Different from the situation in many nuclear countries, Sweden has two separate regulatory bodies, SKI for nuclear safety and SSI for radiation protection. Their missions and tasks have been the same since the beginning of the nuclear programme. On several occasions organisational changes have been considered but not implemented. It has been seen as an advantage that two independent authorities, each from its own viewpoints, review and supervise the nuclear industry. At the same time there has been some overlap in regulations and from time to time some friction between the two authorities. After a review, the special investigator again concluded that a full or partly merger is not justified.

Finally the investigator suggests some minor changes in the Act (1984:3) on nuclear activities and in the Environmental code in order to clarify a few issues where a strict interpretation of the law has created some administrative difficulties and overlaps (see section 7.1).

The investigation has been sent for comments to a large number of organisations.

6.5 The safety situation of the multi-purpose reactors R2 and R2-0 in Studsvik

The two multi-purpose reactors in Studsvik have to comply with the same general safety regulations as the power reactors, although in a graded way. This means that SKIFS 1998:1, 2000:1 and 2000:2 (see article 7) also apply on the MPR's. For both reactors full deterministic safety analyses are required as well as PSA level 1 studies. Also technical specifications and a full set of operating and emergency operating procedures are required. Regarding safety management, the requirements are the same as for the power reactors. There is however a difference in the legal status of the reactors in the way that the MPRs have a licence valid for 10 years. Every 10 years R2 and R2-0 must be re-licensed in order to continue operations. The power reactors have unlimited licences in time, instead of re-licensing they are reviewed every 10 years to verify that they are still safe for continued operation.

The MPR:s are currently under re-licensing. The operator Studsvik Nuclear AB has submitted an application in order to continue operations until 2014. The application includes a safety case covering both reactors and an Environmental Impact Assessment. After a thorough review of these reports SKI has recommended Government to issue a new licence, subject to certain conditions.

The R2 and R2-0 reactors are situated in separate parts (pool 1 and 3) of a common pool in a not fully leak-tight concrete containment. The containment is however supplemented with a subpressure ventilation system and an emergency ventilation system fitted with a filter and scrubber to absorb iodine and cesium in case of an accident. Noble gases are evacuated though a chimney 85 meters high. Both reactors are surrounded with a radiation shield made of iron-ore concrete. The R2 reactor vessel was replaced 1985 due to embrittlement. A current problem with R2 is a water leak in the aluminium liner in the bottom of the pool.

The R2-0 reactor has been modernised 1999-2000 with a completely new core design with low-enriched uranium and a new type of control rods. In addition a new control room was built with a soft ware based control system. The R2 instrumentation and control system is partly outdated which was shown in an event 2002 where automatic scram was not initiated fast enough.

The nuclear fuel is of proven design consisting of U3Si2 with 19.75 % U235 in a matrix of aluminium. The same type of fuel is used in both reactors. One fuel-loading is sufficient for 19 days of operation of the R2-reactor and 0,5-1 year for R2-0.

Spent fuel from both reactors has since their start in 1960 been sent to USA for reprocessing and final storage. This agreement with the US Department of Energy expires in May 2006. As a condition for loading fresh fuel after May 2006, Studsvik Nuclear has to establish a program, approved by SKI and SSI, for the safe final storage of spent fuel after this date and a financing plan.

It is outside the scope of this report to provide a full description of all safey issues for the MPRs. To give an impression of the findings from the latest licensing review, the list of safety issues below has to be addressed by the operator within a specified period of time as a condition for continued operation. Except for the first two hard-ware issues and the development of symptom based procedures, SKI:s remarks have to do with deficiencies of the SAR for each reactor.

- Upgrading of the instrumentation and control system of R2
- Permanent measures to repair the leak in the R2 pool
- Development of symptom based emergency operating procedures
- A safety assessment of the beryllium reflectors and their remaining safe operating time in R2
- A criticality safety assessment for both reactors

- A better integration in both SARs of the deterministic and probabilistic safety analyses
- A more clear consequence assessment of neutron surveillance failures and failures of safety channels in R2
- A description of dimensioning cases for coolant flow blockage in R2
- A description of the reactor hall traverse crane and investigation of consequences of load drops over pool 1-3
- A description of the containment and its design rules and assumptions
- A description of the radiation shield and its design rules and assumptions
- A comprehensive assessment of fuel-handling failures at both reactors
- An update of the SAR for both reactors with the above information as well as reference documents for the R2 SAR

6.6 Conclusion

All the Swedish reactors have undergone comprehensive and continuous safety analysis and showed to comply with existing requirements. Modifications and safety improvements are made on a continuous basis. In addition, major upgrading has been done or are underway for all reactors. Provided that all safety programs are implemented and the operating organisations continue to receive the necessary human and economical resources needed for a proactive safety work, there is nothing identified so far that limits the safe operations of the Swedish reactors. The Swedish Party complies with the obligations of Article 6.

7. Article 7: LEGISLATIVE AND REGULATORY FRAMEWORK

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1. *Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.*
2. *The legislative and regulatory framework shall provide for:*

(i) the establishment of applicable national safety requirements and regulations;
(ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;
(iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;
(iv) the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.

7.1 Nuclear safety legislation and regulatory framework

The basic nuclear legislation

The first report to the Convention includes an extensive overview of the nuclear legislation in Sweden, notably the provisions of the Act on Nuclear Activities (1984:3), the Radiation Protection Act (1988:220) and the respective Ordinances on Nuclear Activities and Radiation Protection. The Rescue Services Act (1986:1102) and the Work Environment Act (1977:1160) were also mentioned in this overview. The Act on Nuclear Activities gives the basic framework for licensing of a nuclear facility and sets out far reaching obligations for the licence holder with regard to nuclear safety, non-proliferation, safe management of spent fuel and waste, and safe dismantling of decommissioned installations. Administrative sanctions combined with fines can be imposed by SKI in cases of non-compliance with regulations and licensing conditions. Strong legal sanctions can be imposed by a court in cases of criminal violation of regulations, licensing conditions or other provisions of the act itself. This basic legislation fulfils all obligations set out by the Convention. The Acts on Nuclear Activities and Radiation Protection have been amended several times as mentioned in the first and second reports to the Convention.

In the second report it was mentioned that the Environmental Code, a general legal framework to support a sustainable development, went into force 1999. This code also applies to nuclear activities in parallel with the Act on Nuclear Activities, since nuclear activities are regarded as hazardous according to the Environmental Code. The authority of SKI and SSI as nuclear regulatory bodies is not affected by the Environmental Code. However, the overlapping legislation may cause some formal problems. Such problems have been pointed out by SKI and SSI to the Government and addressed by the official investigation mentioned in section 6.4.

A nuclear facility must be licensed according to the Act on Nuclear Activities as well as the Environmental

Code, and this shall be done simultaneously and in co-ordination. This means that such a facility must have permits from SKI, SSI and one of the Environmental courts. New nuclear facilities must be approved by the Government, in accordance with a special procedure stated in the Code where a municipality has a veto in certain cases. Moreover, a nuclear facility has to be supervised by SKI and SSI as well as by a county authority. The county authorities are supervisory authorities under the Environmental Code. This means an overlap by different authorities as regards both licensing and supervision of nuclear facilities.

The reactors in Forsmark and Oskarshamn have already been licensed according to earlier environmental legislation. The reactors in Ringhals and Barsebäck must submit applications according to the Environmental Code before the end of 2004. The Environmental court has to take into account the Act on Nuclear Activities and the Radiation Protection Act in its decision on these cases. Assessments by SKI and SSI will of course be a most important input for the court. Licensing conditions decided by the Environmental court may need to be changed later on due to operational experience and the technical and scientific development. At present the county authoritites have, but not SKI and SSI, the authority to submit a case to an Environmental court on new conditions for a nuclear facility, if this facility already has a permit from the Environmental court. Also administrative complications could arise, since the supervisory authorities act independently towards the licensee. In theory they could each decide on different legal measures regarding the same issue and such decisions could be appealed by the licensee to different higher instances.

In has now been proposed to Government to change the Environmental Code in such a way that licensing conditions, orders or regulations, issued according to the Act on Nuclear Activities or Radiation Protection Act, shall apply also in relation to the Environmental Code. The Government has not decided yet on this matter.

Other relevant Acts for nuclear safety

In 2003, a new Act (2003:778) came into force on protection against accidents with serious potential consequences for human health and the environment. Also a new Ordinance came into force under the same title. The Act as well as the Ordinance replaces the earlier mentioned Rescue Services Act (1986:1102) and its Ordinance (see further section 16.1).

7.2 National safety requirements

Existing SKI safety regulations

At present SKI has issued the following safety regulations for nuclear facilities:

- **Regulations concerning Safety in certain Nuclear Facilities (SKIFS 1998:1)**

These basic regulations entered into force in 1999. They have currently been updated and reissued (SKIFS 2004:1). The regulations contain the basic provisions in order to prevent radiological accidents and for conducting an efficient supervision, namely requirements on

- Design and construction in order to apply multiple barriers and defence- in-depth
- Actions in cases of incidents and accidents or at other detection of deficiencies
- Management and control of all safety related activities
- Resources for maintaining and development of safety
- Analysis and review of safety
- Structure and review of safety report (SAR)
- Operations of a facility
- Physical protection and emergency preparedness
- On-site management of nuclear materials and waste
- Documentation and archiving
- Reporting to SKI

General recommendations on the interpretation of the requirements have been issued for most requirements. Except for some clarification and a more modern language, some substantial changes have been inserted through the revision:

- The regulations have been made applicable in a graded way on all licensed nuclear facilities, no matter size or type of facility
- A chapter on decommissioning has been added with requirements on decommissioning plan and a specific operational safety assessment to be done as soon as a decision has been taken on final closure of a facility
- Extended requirements on safety management (see further section 12.1)
- Integration of physical protection in the general safety concept
- More stringent requirements on periodic safety review (see further section 14.1)
- More stringent requirements on operability verification (see further section 14.1)

• **Regulations concerning the competence of Operations Personnel at Reactor Facilities (SKIFS 2000:1)**
These regulations, in force since 2001, include requirements on competence analysis, competence assessment, authorisation by the licensee, recruitment and training for a position, and retraining of operations personnel belonging to the categories operations management, control room personnel and field operator. If an individual satisfies all requirements regarding competence and suitability, the licensee may issue an authorisation valid for three years. Every year an intermediate follow up evaluation shall be done in order to check that the essential competence is maintained. The regulations also contain requirements on simulators used for operational training. Attached to the regulations are general recommendations for their application.

• Regulations concerning Mechanical Components in certain Nuclear Facilities (SKIFS 2000:2)
These regulations went into force 2001. They are an update of older regulations on mechanical components in nuclear installations (SKIFS 1994:1). Adaptations have been made to the safety review, notification and reporting principles in accordance with the general safety regulations SKIFS 1998:1. No other major changes have been made of the previous requirements for measures, control and inspection activities to be taken during plant modifications, maintenance and in-service inspections.

The new regulations, however, include more precise requirements for design specifications and assessments of such specifications when plants are to be modified. More stringent requirements have also been introduced for assessing the safety impact of continued operation with components that are degraded to a certain level.

Furthermore, the guidance for in-service inspections has been changed. In SKIFS 1994:1 a qualitative risk oriented approach, with division into three different control groups, was recommended to identify inspection areas and to define inspection targets. The overall experience of the application of this approach, which has been used in Swedish plants since the early nineties, is positive. This risk oriented system is transparent, easy to use and to manage. Degradation seems to be detected at an early stage before the safety level is affected. With better risk insights based on the development of more detailed PSA-models as well as probabilistic fracture mechanics models, opportunities for improvements exist. The guidance in SKIFS 2000:2 therefore puts more focus on important aspects to be considered when applying different qualitative and quantitative risk oriented approaches.

• Regulations on Safety at Final storage of Nuclear materials and Nuclear waste (SKIFS 2002:1)
These regulations, in force since 2002, contain specific requirements on design, construction, safety analysis and safety report for final repositories, in view of the period after closure of the facility. For the period before closure, the general safety regulations updated as SKIFS 2004:1 apply.

SKI safety regulations under way

Work is in the final stage for issuing of two additional safety regulations supplementing the general safety regulations SKIFS 2004:1. The new regulations are planned to be in force from 1 January 2005.

• Regulations on Design and Construction of Nuclear Power Reactors (SKIFS 2004:2)
These regulations contain requirements on design principles, withstanding of failures due to internal as well as external events, environmental qualification, main and emergency control room, safety classification, event classification, and requirements on the design and operation of the reactor core (see further section 18.1).

• Regulations on Physical Protection of Nuclear Facilities (SKIFS 2004:3)
These unclassified regulations contain requirements on organisation of the physical protection, clearance of staff, tasks for the security staff, requirements on central alarm station, perimeter protection, protection of

buildings, protection of compartments vital for safety, access control for persons and vehicles, protection of control rooms, communication equipment, search for illegal items, handling of information about the physical protection and IT security. Design details about the physical protection shall be reported in a secret attachment to the SAR of the facility. These regulations replace older requirements from 1975.

SKI has no current plan to issue any more safety regulations for nuclear facilities.

SSI regulations on radiation protection

Some changes have been made in SSI regulations since the second report to the Convention. At the end of 2003 there were a total of 49 SSI-regulations in force, covering all areas of radiation. 12 of these are directly applicable to the nuclear industry. Many of these regulations, presented below, have been adjusted in accordance with new radiation protection legislation of the European Community. The regulations are also in agreement with recommendations by IAEA and ICRP.

- **Regulations on Planning Before and During Decommissioning of Nuclear Facilities (SSI FS 2002:4)**

These regulations entered into force in 2004. The regulations contain provisions concerning the planning of decommissioning of nuclear facilities in matters of importance from a radiation protection point of view. Requirements are put on decommissioning planning and other administrative measures such as documentation before and during decommissioning and reporting to the SSI at different stages of a facility's life cycle.

- **Regulations on Handling of Radioactive Waste and Nuclear Waste at Nuclear Facilities (SSI FS 2001:1)**

These regulations contain provisions concerning the planning and quality assurance of radioactive waste management at nuclear facilities, as well as documentation and registration of radioactive waste and reporting to the SSI

- **Regulations on Protection of Human Health and the Environment from Discharges of Radioactive Substances from certain Nuclear Facilities (SSI FS 2000:12)**

These regulations are applicable to all releases of radioactive substances from nuclear facilities that are directly related to the normal operation at each facility. The effective dose to an individual in the critical group of one year of releases of radioactive substances to air and water from all facilities located in the same geographically delimited area shall not exceed 0.1 millisievert (mSv).

- **Regulations on Radiation Protection Manager at Nuclear Plants (SSI FS 2000:11)**

According to these regulations a license holder shall appoint a radiation protection manager at the facility in order to implement and look after radiation protection conditions issued by the authorities.

• **Regulations on Radiation Protection of Workers Exposed to Ionising Radiation at Nuclear Facilities (SSI FS 2000:10)**
These regulations apply to the radiation protection of workers at nuclear facilities and regulate several different areas as optimisation, education, demands on local instructions, controlled areas, personal radiation surveillance, procedures connected to fuel elements, reporting and documentation.

• **Regulations on Medical Examinations for Radiological Activities (SSI FS 1998:6)**
These regulations are general and apply to all kind of radiological workers of category A with ionising radiation.

• **Regulations on Monitoring and Reporting of Individual Radiation Doses (SSI FS 1998:5)**
These regulations apply to measurements of individual radiation doses to workers of category A working with ionising radiation and reporting of doses received to the National Dose Database.

• **Regulations on Dose Limits at Work with Ionising Radiation (SSI FS 1998:4)**
These regulations apply to the limitation of radiation doses to workers and the general public resulting from applications using ionising radiation. The regulations also apply to the protection of pregnant women who otherwise might be exposed to ionising radiation by their work.

• **Regulations on Categorisation of Workplaces and Workers at Work with Ionising Radiation (SSI FS 1998:3)**
These regulations apply to applications using ionising radiation where humans may receive radiation doses.

• **Regulations on the Protection of Human Health and the Environment in connection with the Final Management of Spent Nuclear Fuel and Nuclear Waste (SSI FS 1998:1)**
According to the regulations human health and the environment shall be protected from detrimental effects of ionising radiation, during the time when the various stages of the final management of spent nuclear fuel or nuclear waste are being implemented as well as in the future.

• **Regulations on Filing at Nuclear Plants (SSI FS 1997:1)**
These regulations apply to the filing of documentation that is drawn up or received in connection with the operation of nuclear plants. If the practice ceases, the archives shall be transferred to the National Archives of Sweden.

• **Regulations on Outside Workers at Work with Ionising Radiation (SSI FS 1996:3)**
These regulations apply to outside workers of category A working within controlled areas in Sweden and when Swedish workers of category A perform similar tasks in other countries.

7.3 Licensing system

As mentioned in the first report to the Convention, the Act on Nuclear Activities includes the basic legal requirements on licensing, and the legal sanctions to be imposed on anyone who conducts nuclear activities without a licence. For major installations and activities, the licence is granted by the Government on the recommendation of the regulatory bodies. For all the existing Swedish nuclear power plants, the licences are valid without time limit, although licensing conditions can be limited in time and function as control stations. If the licensee complies with all legally binding safety requirements, a prolongation of the licence cannot be denied in principle. A licence can be permanently revoked if licence conditions are not complied with, or for other serious safety reasons. Revoking a licence for other reasons than safety, as in the Barsebäck 1 case, a special law is required. As mentioned in section 6.2, in Sweden there is a legally binding requirement to conduct a periodic safety review of every reactor unit every ten years of operation. One purpose with this review and its regulatory assessment is to determine whether the units still comply with all regulations and licensing conditions, and that safety is developing as required.

7.4 Regulatory inspection and assessment

Regular inspections and safety assessments are carried out by SKI and SSI authorised by their respective laws and mandates given by the Government.

SKI practices

As mentioned in the second report to the Convention, SKI has developed its inspection practices a lot since issuing of the general safety regulations (SKIFS 1998:1). These regulations made it possible to adopt a more structured approach to inspection and safety assessment.

Over the last three years SKI safety inspections have focussed on the following themes:

- How investigation of events involving man-technology-organisation is carried out
- How operations are controlled during unclear plant conditions.
- How primary and independent safety reviews are carried out.
- How the use of contractors is managed in order to comply with the Act on Nuclear Activities.
- How updating and use of PSA is managed.
- Emergency management and emergency preparedness planning.
- Event reporting to SKI.
- Extensive inspection of safety management, preventive maintenance, core management, quality

audits and in-service inspection.
- Nuclear waste management.
- Competence follow up and training of plant staff with tasks important for safety.

Inspections always result in extensive reports covering the purpose and objects of the inspection, observations, compliance and deviations from requirements, an assessment of the magnitude and safety significance of any deviations and a proposal on further regulatory action. If it is found that the licensee needs to take further minor action in order to fully meet the requirements, SKI issues an order that an action plan shall be developed and submitted within a certain time period. If larger gaps are found, the licensee has to take specific actions within a certain time period and submit the results to SKI for review. If major deviations from requirements are found, SKI makes a decision to stop operations until the deficiencies are corrected, and measures taken which must be reviewed and approved by SKI. In such cases SKI also has to decide whether to submit the case to a public prosecutor for legal investigation. In some of the inspections mentioned above, SKI required action plans to be submitted and measures taken within a certain time period.

Besides inspections SKI apply another type of less intensive plant visits named ”covering of current plant issues”. There are several purposes with these visits, e.g. to be kept generally informed about activities at the plants, to collect information about occurred events, plans, status of ongoing projects, to follow up on SKI regulatory decisions, etc. Another important purpose is to have a practical possibility to detect early signs of declining performance. The information is mainly used by SKI for preparation and planning of regulatory activities. Preparation and documentation is much simplified in comparison with inspections, but results are documented in a systematic way and announced at the SKI management meetings. Since ”covering of current plant issues” have shown to be a good practical instrument for the regulatory body, rather many such visits are made as shown in the table below. Each visit typically takes one or two days on-site for one or two inspectors. Often another SKI staff member, who is a specialist on the subject matter of the visit, accompanies the inspector.

NPP	2001	2002	2003
Barsebäck	13	15	22
Forsmark	23	22	23
Oskarshamn	22	38	30
Ringhals	19	25	25
Total	**77**	**100**	**100**

Table 5: Number of plant visits done by SKI 2001-03 within the programme ”covering of current plant issues”

As also mentioned in the second national report, SKI has developed a new practice called the SKI Forum. This is a regular annual and integrated safety assessment of each major facility under SKI supervision. Based on all inspections and safety assessments directed towards the facility, as well as information from ”covering of current plant issues”, a general conclusion is made about the safety- and non-proliferation control status of the facility in relation to relevant requirements. A document, covering the status in 15 areas, including plant safety, waste management, physical protection and safeguards requirements as well as preliminary conclusions, is circulated by the inspection department before each Forum. Under the chairmanship of the reactor safety office director, the preliminary conclusions are scrutinised and amended, by a group of experts representing all relevant areas. Notes are taken and the minutes are approved by the three SKI office directors. The minutes are an important tool in prioritising further regulatory activities. They are also discussed with the respective plant management shortly after each Forum. SKI Forum has now become an established practice at SKI and found to be most valuable for maintaining an updated picture within SKI of the safety issues of the plants, and for prioritising and planning of other regulatory activities. It has also shown to be a strong information basis for top management discussions between SKI and the licensees.

Besides the mentioned practices, SKI also has a special instrument called ”special supervision”. The use of this supervision is decided by the director general and is applied in cases where SKI is not satisfied with the safety performance of a nuclear facility. It can also be applied for other special safety reasons, e.g. during testing operation after large plant modifications. The special supervision regime means that inspections are made on a tighter schedule and special progress reporting is required of the licensee. Special supervision has been applied in a few cases, an ongoing case is Barsebäck 2 where SKI more closely wants to follow developments after the so called thermal mixer event (see section 6.1). Special supervision is formally terminated when SKI is satisfied with the improvements made or the special safety reason is no longer valid.

SSI practices

Since the second national report, SSI has further developed its policy for inspection in order to create an updated and applicable programme for all areas and activities, which SSI has to supervise. All quality and policy documents for different kinds of official actions and standpoints are collected in the quality management system. SSI:s inspection policy defines the following types of inspections:

System inspections: During system inspections the licensee organisation, administrative routines, co-ordination within the organisation, division of responsibilities and competence are in focus. The aim of system inspections is to obtain good knowledge of the management system of the licensee.

Detailed inspections: A detailed inspection is concentrating on one specific issue. A detailed inspection could e.g. be triggered by an unexpected radiological event.

Theme inspections: A theme inspection is co-ordinated and performed towards several licensees, on a specific theme (e.g. air monitoring programme at the nuclear facilities).

Joint SKI-SSI inspections: Because of the strong links between nuclear safety and radiation protection, SKI and SSI need to co-operate in the supervision of the nuclear facilities. Usually the two authorities co-operate in major safety assessments. Joint inspections are carried out occasionally., for instance in the field of emergency preparedness.

SSI spent 43 days for inspecting workers protection in 2003 (50 days in 2002). Corresponding values for waste and environmental inspections are 18 days in 2003 (24 days in 2002).

7.5 Conclusion

The Swedish Party complies with the obligations of Article 7.

8 Article 8: REGULATORY BODY

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1. *Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*
2. *Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy*

8.1 Regulatory bodies and their mandates

The first report to the Convention includes a rather extensive description about the organisation, missions and tasks and reporting obligations of the two nuclear regulatory bodies in Sweden; the Swedish Nuclear Power Inspectorate (SKI) and the Radiation Protection Authority (SSI). Only minor changes have taken place in the last years. The missions and tasks of the two authorities follows from the respective laws and ordinances (see section 7.1) and the annual government letter of appropriation which contains more detailed objectives and reporting obligations.

The Swedish Nuclear Power Inspectorate (SKI)

The SKI missions are conducted within three main areas: reactor and nuclear materials safety, nuclear non-proliferation and nuclear waste safety. In addition SKI is involved in international development co-operation within these areas, through two separate units reporting directly to the Director General. Within reactor and nuclear materials safety, SKI has the following tasks as specified in the 2003 letter of appropriation:

1. Maintain effective safety requirements
2. Supervise licensee's responsibility for safety
3. Push safety work forward nationally and internationally when motivated by experience, research and development
4. Develop and maintain national competence with regard to nuclear safety
5. Maintain preparedness for advising other authorities in cases of nuclear emergencies
6. Maintain an active information, reporting and transparency towards the public

All these tasks have to be assessed and reported back to the Government annually. The SKI organisation is shown in figure 3 on next page.

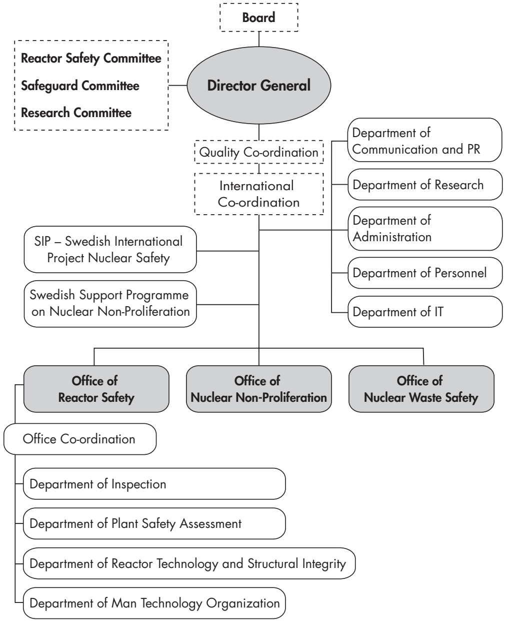

Figure 3. The SKI organisation

The Swedish Radiation Protection Authority (SSI)

In the 2003 letter of appropriation for SSI, some areas are pointed out that should be paid particular attention as quality objectives. The first activity goal for Nuclear Energy Supervision and Preparedness is the protection of workers. Transportation of radioactive substances and decommissioning of nuclear facilities shall be performed in a safe way from radiological point of view. The second goal is safe handling of radioactive waste, as well as limitation of emission of radioactive nuclides. Further the decommissioning of nuclear installations should be performed in such a way that radiation doses to workers and the general public, and the radioactive waste produced, are all dealt with in a safe manner from radiological point of view. The third activity goal for SSI in this field is national emergency preparedness. It is pointed out that the Swedish national emergency preparedness of high class shall be maintained, developed and co-ordinated with Sweden's international responsibilities.

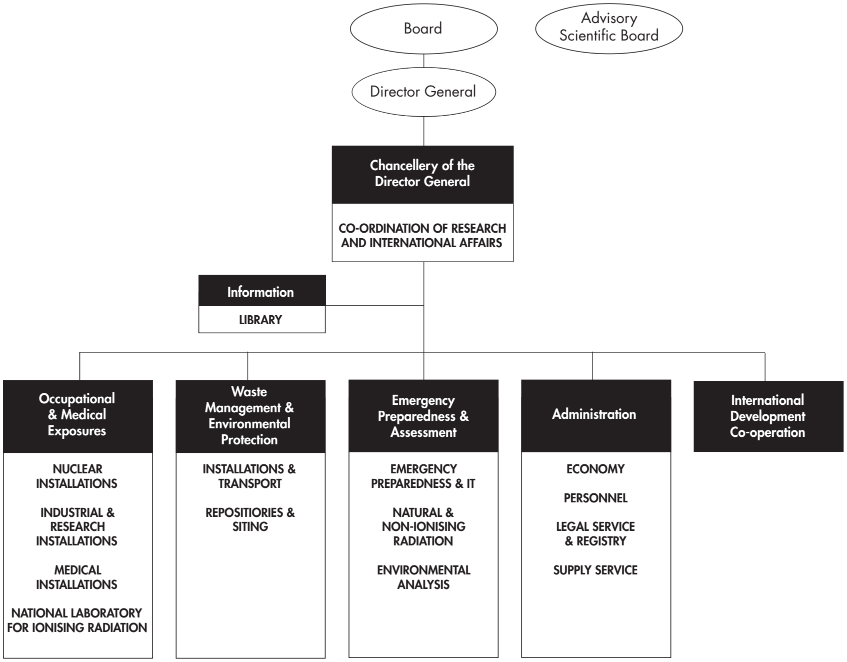

Figure 4. The SSI organisation

SSI had a minor reorganisation in 2003 and does now operate within four main areas:

- Nuclear energy supervision and emergency preparedness against radiation accidents
- General supervision
- Environmental supervision
- Radiation protection research

In addition to the four main departments, shown in figure 4 there is a special department for radiation protection support to the Central and East European countries: the International Development Co-operation. The programme is operationally independent from SSI but reports directly to the Director General.

8.2 Human and financial resources for regulatory activities

Staffing

SKI presently (2003) has a staff of 118. This has been a constant figure over the last three years and a slight increase since 1998 (111). 47 persons belong to the Office of Reactor Safety, thus dealing with supervision of the 11 operating nuclear power reactors, the research reactors and the fuel factory. The average employment time at SKI is 10 years. 45 % of the regulatory staff is older than 50 years, 25 % is younger than 39 years. Three to four persons will retire each year up to 2010. A lager retirement rate will come after 2010. The staff turnover rate including retirement was 8 % during 2003, which is a little more than normal.

SSI presently (2003) has a staff of 106 persons. This is a slight decrease in the total number of employees from the earlier reporting period (108 in 2000). Of these approximately 30 are occupied with matters in direct connection to the supervision of nuclear facilities. Many of these are scientists in the area of physics and radiation physics. There are also radio ecological physicians and biologists. The average length of employment is 15 years, and more than 50 % of the staff had been employed more than 10 years. Staff turnover in 2003 was 9 %.

In the staff of both regulatory bodies there are also lawyers, IT experts, information and administrative personnel. About 10% of the working time is allocated to the development of individual competence.

At both authorities one inspector per site is designated as site responsible, serving as the main contact point between the facility and the authority.

The distribution of educational background in 2003 was as follows for SKI and SSI:

Education	SKI staff	SSI staff
Post Graduate Degree	24	26
Bachelor/Master	65	55
Secodary High School	27	20
Other	2	5
Total	**118**	**106**

Table 6. Educational background of the staff at SKI and SSI, number of people in different categories.

Compared with most other agencies, the staffs of SKI and SSI have a rather high educational level. This has to do with the many specialist areas, which have to be covered by the regulatory bodies, and to some extent with the fact that there is no regular TSO in Sweden to back up the regulatory bodies with specialist knowledge.

Internationally the numbers of regulatory staff at SKI and SSI are quite small for the size of nuclear programme they have to supervice. Each professional staff member is typically involved in several tasks, for instance inspections, regulatory reviews and approval tasks, revision of regulations, handling research contracts and participation in public information activities, each requiring his or her expertise. When comparing the sizes of staff between different countries, it is however important not only to count staff members per reactor, but also to consider the types of legal obligations put on the licensees and the different inspection practices.

Audits of SKI in mid 1990's indicated that the workload of the staff was very high and that most resources were used to respond to applications and events, with the consequences that much of the long-term development and research work received too low priority. As mentioned in the two first reports to the Convention, resources have been increased and together with new supervision procedures and the activity planning system launched a few years ago, the situation has become better. During the coming years SKI again expects a high workload depending on extensive modernisation of the Swedish reactors (see section 6.3 and 18.2), as well as expected applications to uprate the power levels of several reactors and the special safety assessments 2010 of seven reactors, as ordered by the Government. This makes it important to implement a very good long term planning and to develop the necessary assessment and administrative tools to deal with the tasks without overloading the staff. Such planning has already begun. SKI cannot expect any more substantial increase of resources. However, legal possibilities exist to invoice the licensees for tasks such as review of safety cases for power uprating. This makes it possible to employ temporary reinforcement.

Economical resources

As mentioned in the earlier reports to the Convention, the regulatory activities of SKI and SSI are financed over the state budget. However, they have a neutral impact on the budget since the costs are recovered by the Government from the licensees, as regulatory and research fees. The budgets[8] for 2003 are shown in table 7 as compared to 1998 and 2000. Administration includes salaries and operational expenses.

As can be seen in the table the economical resources of the regulatory bodies have been maintained and increased in real terms over the last years.

Appropriation	1998	2000	2003
SKI Admin	76 279	82 648	95 485
SKI Research	63 950	65 969	72 015
SKI Total	**140 229**	**148 617**	**167 500**
SSI Admin*	78 645	73 800	111 300
SSI Research*	12 000	14 400	13 300
SSI Total*	**90 645**	**88 200**	**124 600**

Table 7: Budgets of SKI and SSI in KSEK. 1 SEK is about 0.11 EUR. *) All radiation protection applications.

[8] According to governmental letter of appropriation. Added to these figures are som reservations from earlier years which need a special permission to be used.

8.3 Regulatory reactor safety research

In 2002 SKI submitted a report to the Government on its future research strategy[9]. The report was requested because of concerns over the future availability of nuclear experts.

In this report SKI states as its overall research goal are that SKI continuously shall have the knowledge, necessary expertise and resources to conduct its regulatory and supervisory activities effectively. Furthermore SKI shall contribute to ensuring that national expertise and research capability are available.

Research is mentioned as a prerequisite for SKI to be able to conduct its regulatory activities. The report contains a systematic review of the regulatory challenges that need research. Currently such research focuses on 16 strategic areas such as safety analysis and assessment, human factors, materials and chemistry, structural integrity, surveillance and testing, thermal hydraulics, nuclear fuel, severe accidents, process control, emergency preparedness, nuclear waste, nuclear safeguards, regulatory strategies and direct support to university education and research.

With regard to access to research and expertise, the report mentions the big changes in Swedish nuclear infrastructure over the past decade. The main BWR reactor vendor Westinghouse Electric Sweden (former ASEA-Atom and ABB Atom) has downsized and education and research in the nuclear area at universities have been considerably reduced. A review of the availability of expertise in Sweden shows that, in many areas, resources are still adequate, but in certain cases SKI needs to provide focused support in order to maintain the expertise that SKI needs for its regulatory and supervisory activities. The analysis highlights two areas without any real education and research: "Materials testing and control" and "Management, control and organisation of safety related activities". Education and research in the latter area lacks a safety perspective. SKI intends to take the initiative to conduct work within both of these areas.

Since national research resources are limited, SKI has, for a long time, actively participated in international research. There is a clear trend that international co-operation is increasing, also for safety research. SKI is prioritising co-operation on research conducted in the OECD/NEA and is participating in a large number of projects organised within this framework. An example is the Halden Project in Norway, which conducts research of importance for fuel, materials and human factors. Since Sweden joined the EU, the importance of joint European work has increased. SKI is itself also actively participating and supporting Swedish organisations participating in European Commission projects and intends to support such projects in future. Furthermore, in the safeguards area, important joint work is underway in ESARDA (European Safeguards Research and Development Association).

Experience has shown that a prerequisite for taking advantage of international research and expertise is that activities on the national level should be of an adequate scope within each area. Furthermore, it has been found that, in order to promote strategic expertise, active work on the issues must be conducted in addition to following up developments. In SKI's opinion, the increased co-operation offers the possibility of gaining access to important research information at a relatively modest cost.

In recent years, concerns have been expressed regarding the possibility of maintaining adequate strategic expertise in the nuclear field. To explore this issue, SKI investigated the needs in the strategic expertise areas

[9] The report "SKI's Research Strategy" is available in English. SKI Report 02:45, October 2002.

today and within a ten-year perspective. SKI also investigated the extent to which this expertise is satisfied by university education. The investigation shows that the annual university recruitment need is a total of about 50 people within the strategic nuclear areas. In SKI's opinion, the education capacity in these areas is adequate at present and is assured for the foreseeable future as a result of the measures taken by SKI and the nuclear industry through the Swedish Nuclear Centre (SKC).

There is also a concern regarding expertise and resources for conducting qualified experiments. Over the past ten years, several of the world's research reactors and experimental facilities in thermal hydraulics have been decommissioned. The OECD/NEA has investigated this issue in a report that clearly highlights this disturbing trend. NEA has therefore taken the initiative to support ”Centres of Excellence” (CoE), which are defined as international research groups associated with important experimental facilities. In practical terms, the support is provided through the development of recognised research programmes at these facilities and through ensuring that these programmes have international support.

In parallel, within the Sixth Framework Programme, which started in 2003, EU has used the term ”Networks of Excellence” (NoE), where the aim is to achieve co-operation between researchers within a specific research discipline.

SKI has investigated the possibility of proposing a CoE in Sweden or of participating in NoE, in order to support important research conducted in Sweden. SKI sees a possibility that the Studsvik R2-reactor and the fuel experiments that can be conducted and analysed at this reactor could constitute a CoE. Studsvik has prepared a preliminary programme and the preliminary cost would be about SEK 12 million/year for about five years. The SKB Hard Rock Laboratory at Äspö could also comprise a CoE. With respect to NoE, SKI currently envisages two possibilities: the Department of Nuclear Safety at the Royal Institute of Technology, Stockholm (KTH) within the area of thermal hydraulics and severe accidents as well as within human factors (man-machine-technology). SKI intends to support the efforts to set up a CoE or to participate in a NoE.

SKI's conclusions to the Government were summarised in the following way:

- International research yields a high benefit for invested efforts and intends to prioritise national expertise development based on international work
- With the current support to universities, the level of education and research within nuclear-related subjects will be satisfactory in the foreseeable future
- SKI intends to take the initiative to ensure that work starts within the areas of ”Materials testing and control” and ”Management, control and organisation” to rectify deficiencies within these areas with respect to resources for education and research
- The current level of funds allocated to SKI for research must be maintained in order to provide the necessary support for the regulatory and supervisory activities and ensure the availability of competent personnel
- SKI intends to continue discussions with the industry concerning CoE and NoE and intends to report to the Government on this issue. If Sweden is to be able to participate in a CoE and other international networks and research projects then SKI cannot exclude the need for increased research funding.

8.4 Regulatory radiation protection research

The SSI research budget is used for research in all areas of radiation protection, relating to ionising radiation as well as non-ionising radiation. Approximately 40 % of the budget is used for research directly related to nuclear energy production, such as radioecology, radiation protection of power plant workers, emergency preparedness, nuclear waste matters, and questions related to risk perception and acceptance of waste disposal. 25 % of the budget is used for non-nuclear research, i.e. mainly medical and technical applications and uses of radiation. 25 % is used for non-ionising radiation (UV, EMF). 10 % of the budget is used for basic research of importance to all areas of radiation protection, mainly radiobiology.

8.5 Quality management of regulatory activities

SKI

As mentioned in the second national report, SKI has devoted considerable effort to develop and implement a new management system. This system (SKIQ) builds on the basic philosophy behind the Swedish Quality Award (similar to the EFQM model) of the Swedish Institute for Quality Development. The focus is on a systematic improvement of processes and practices. SKIQ includes four basic chapters (1-3 and 9) and 14 process descriptions:

1. The tasks and missions of SKI
2. What is SKIQ? (description of the system and its application)
3. The SKI organisation, authorities and responsibilities
4. Activity planning, follow-up and reporting
5. Competence supply (recruitment and training of staff)
6. Development of the work environment
7. Document control and registering
8. General internal administration
9. Regulatory supervision- principles and direction (documentation of the regulatory philosophy)
10. Issuing of regulations and general recommendations
11. Safety review of licensee applications and SKI investigations of events
12. Inspection and ”covering of current plant issues”
13. National non-proliferation control
14. Experience feed-back of safety related events and conditions
15. Integrated assessments of safety and the control of nuclear material
16. International work
17. Research
18. Information (external and internal)

The full management system has been in operation since 2002. Experiences are good so far. The documents are available to all staff through the intranet, and document templates, links to reference material etc are provided on line. Internal audits have been conducted of some of the processes and needs for revisions have been identified. It is clear that resources are needed to maintain and develop the system further.

SSI

See section 7.4.

8.6 Independence of the regulatory bodies

The de jure and de facto independence from political pressure and promotional interests are well provided for in Sweden. The laws governing SKI and SSI concentrate solely on nuclear safety and radiation protection. Both regulatory bodies report to the Ministry of Environment, which has nothing to do with the promotion or utilisation of nuclear energy. An individual minister cannot interfere with the decision making of a governmental agency according to fundamental Swedish law. This is a matter for the Government, in plenum.

8.7 Conclusion

The Swedish Party complies with the obligations of Article 8.

9. Article 9: RESPONSIBILITY OF THE LICENCE HOLDER

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

9.1 The legal requirements

As mentioned in the first two reports to the Convention, and in chapter 7, the Swedish Act on Nuclear Activities is very clear about the prime responsibility for safety, for instance § 10 states the following:

> 10 §: The holder of a licence shall be responsible for ensuring that all measures are taken which are needed for
> (1) maintaining safety, with reference to the nature of the activities and conditions in which they are conducted,
> (2) ensuring the safe handling of the final disposal of nuclear waste arising in the activities or nuclear material arising therein and not reused, and
> (3) the safe decommissioning and dismantling of plants in which nuclear activities are no longer to be conducted.

In the prework to the acts it is mentioned that the licensee must not only do what is needed to maintain safety, but also be active in order to keep safety and radiation protection at the highest possible level.

The updated safety regulations (SKIFS 2004:1) further clarify this responsibility through a number of requirements on safety management, design and construction, safety analysis and review, operations, nuclear materials-waste management and documentation/archiving. In addition it is clearly pointed out in these regulations (Chapter 2, § 9 point 8) that safety shall be monitored and followed up by the licensee on a routine basis, deviations identified and handled so that safety is maintained and further develops according to valid objectives and strategies. The meaning of this is that a continuous preventive safety work is legally required, including safety reassessments, analysis of events in the own and other facilities, analysis of relevant new safety standards and practices and research results. Any reasonable measure useful for safety shall be taken as a result of this proactive and continuous safety work and be documented in a safety programme that shall be updated annually (Chapter 2, § 10).

9.2 Measures taken by the license holders

A number of measures, also described in the two earlier national reports, give evidence that the Swedish licensees have accepted the prime responsibility for safety. The following can be mentioned as examples where activities are more or less constantly ongoing.

Safety policies

Vattenfall AB and Sydkraft AB have issued safety policies as the highest-level documents expressing the most important corporate values, valid for all divisions and subsidiaries of each company. The policies contain a basic view on the safety issues and establish ambition levels and priorities, and state that the utilities should:

- Take safety initiatives on their own
- Maintain an open dialogue with the regulators and with other companies on safety issues
- Regard regulations as the minimum standard to be met with reassuring margins
- Take an active and leading role in research and development
- Strive for the continuous improvement of safety.

Implementation of the safety policies is further described in chapter 10.2.

Continuous upgrading of the plants

These projects and programmes are discussed in sections 6.2 and 6.3. It is clear from these descriptions that the utilities take substantial initiatives to assess and upgrade the reactors.

International safety reviews

International peer reviews are performed at the initiative of the licensees. Since the first report to the Convention, WANO peer reviews have been performed in Ringhals 1998, Oskarshamn 1999 and Barsebäck 2000 giving valuable recommendations for the improvement of safety.

These reviews have lifted issues that would otherwise not have been given the same level of attention, for instance specific areas where safety culture could be improved. A WANO peer review will be conducted in Forsmark in 2004.

Participation of Swedish staff, in international peer reviews outside of Sweden, is considered of great value to the individuals as well as their plant organisations.

Corrective measures

The operators, in line with the general intentions of the safety policies, often take safety initiatives without being forced to by regulations or formal internal requirements. One specific example on initiatives taken and openness shown is the actions taken by Forsmark in 2003 when, as a result from an analysis, it was found that loss of ordinary heating and ventilation systems during cold weather situations could have significant safety implications. Forsmark in this case performed further analyses, took corrective measures and forwarded the information to other operators through KSU and ERFATOM.

9.3 Conclusion

The Swedish Party complies with the obligations of Article 9.

10. Article 10: PRIORITY TO SAFETY

Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

10.1 Regulatory requirements

The updated safety regulations, SKIFS 2004:1 chapter 2, 7-10 §§, contain a number of provisions with regard to priority to safety, such as:

- The operating organisation shall have the necessary resources and be designed to maintain safety
- A management system shall be implemented so that requirements on safety are met in all relevant activities
- There shall be documented safety objectives and safety strategies showing that safety is always prioritised
- Activities shall be planned in such a way that necessary time is allocated for safety measures and safety review
- Safety decisions shall be preceded by sufficient safety investigation and review, for instance an independent safety committee should be used to review issues of principal importance for safety
- Relevant operational experience shall be continuously assessed and reported to the relevant staff
- Safety shall be assessed and followed up on a routine basis, deviations identified and measures taken so that safety is maintained and developed according to the established safety objectives and strategies
- After taken into operation, the safety of a facility shall be continuously analysed and assessed in a systematic way. Necessary technical and organisational measures to be taken as a result of this analysis and assessment shall be included in an established safety program. This program shall be evaluated and updated annually.

10.2 Measures taken by the licence holders

Safety policies

The earlier mentioned safety policies issued by Vattenfall AB and Sydkraft AB have been interpreted and further developed in the safety policy documents of each nuclear plant management. The safety policies of the parent companies are reviewed periodically by the Safety Councils, but have not been changed in recent years.

Safety management provisions

- Safety Councils have been established at the corporate levels in order to review major and more principal safety issues. In the Sydkraft approach, a number of external nuclear experts are members of the Safety Council. One member of the council is also the safety manager of the Ringhals group, where Sydkraft has a minority interest. This should be seen in the light of striving for openness when it comes to safety issues.
- The level of safety in plant operations is monitored in several ways, including the use of performance indicators. The Safety Index, described in the second report to the Convention, is used by all plants in the Vattenfall group (Ringhals, Forsmark and Barsebäck). OKG has not developed a similar concept but has started to benefit from the performance indicator index being developed by WANO.
- The quality assurance systems (see section 13) have for all plants been developed towards management systems and constitute an essential part of the safety management provisions, based on a quality policy and outlined in management- and quality handbooks.
- Vattenfall has introduced a yearly reporting to the Vattenfall board on the safety of Vattenfall nuclear stations. The report is presented by the director of business area Generation, and includes a presentation of safety performance indicators. The board has no formal legal nuclear responsibilities, but needs this information to assess the business risks associated with nuclear operations.

Safety culture programmes

Maintaining a strong safety culture in the operation of nuclear plants is considered vital by the Swedish utilities and is emphasised in the policies of the different plants and in their strategic plans. Management at all levels, including the managing directors, is involved in activities to enhance the safety culture and to stress the responsibility of all personnel to work actively in maintaining and developing the safety culture standard.

The activities in the safety culture area at the different sites comprise amongst others the following items:

- A questionnaire for safety climate surveys is used at all plants. They provide a measure of the safety climate (or safety culture) of the organisations, and can be used as a safety indicator and an initiator for safety improvements. The survey is repeated periodically and new measures and programmes are initiated based on the outcome of the survey. It has been seen in some cases that organisational changes have impacted the results.
- Training and discussion sessions on safety culture are arranged regularly e.g. as part of retraining programmes. Annual sessions are arranged for operations and maintenance personnel at some plants, where one full day has been devoted to safety culture issues, often including discussions in groups with different categories of personnel. This type of discussion has proved to be successful and will be continued in future training programmes.
- On certain occasions, e.g. after safety culture related incidents, special information and training ses-

sions have been arranged to discuss safety culture and emphasise the importance of high standard on safety culture both for plant safety and for maintaining public confidence in nuclear power. Experts from WANO and IAEA have been invited to such workshops. The event in Barsebäck 2 in 2003, described in section 6.1, and the criticism expressed and followed by ”special supervision” by SKI, is a recent example where this has been practised.
- The associate professorship on human factors including safety culture at Mälardalens Högskola, a regional university collage, has recently been prolonged for another three years. The professorship is sponsored by the Swedish utilities and comprises 75 % of full-time.
- LearnSafe, an extensive development project in the area of learning organisations, and including safety culture aspects, has been performed in the last few years. The project involved participants from several European countries including Swedish nuclear plant organisations and was supported by the European Union. The result of the project is briefly described in section 12.2.

International peer review

As described in chapter A 5, the utilities participate in extensive work in the nuclear safety area both nationally and on the international level. Experience feedback on technical matters has been gained in connection with reviews undertaken by international review teams in the IAEA and WANO framework, described in section 14.2. The engagement from Swedish plants has increased in participating as peers abroad in these programmes. The purpose of this is not only to assist the hosting plant but also to gain experience on the spot on how the host plant deals with safety and other essential issues.

10.3 Regulatory control

The first two national reports report mentioned a number of regulatory actions that had been taken in order to make sure that licensees give adequate priority to safety. Two measures have shown to be of great importance for the dialogue between SKI and the licensees with regard to resources and priorities of safety. These are

- The practice of SKI Forum (see section 8.2). SKI Forum provides an updated comprehensive regulatory assessment of the safety of the facility under rewiev. A management meeting follows each SKI Forum.
- Regular top management meetings with the licensees. The director general of SKI and the office directors meet with the management group of each nuclear power plant and other major facilities at least once a year to discuss current issues and safety priorities. There are also meetings with the corporate chief executives of the utilities every year.

10.4 Measures taken at SKI to prioritise safety

One basic idea behind the management system (SKIQ) is that SKI shall devote its supervision resources to the most important safety issues. The annual activity planning system takes as its starting point the current regulatory challenges, which are documented, as well as input from SKI-Forum and other regulatory processes, e.g. inspection, international work and research, indicating that SKI needs to devote regulatory resources to certain facilities and safety issues. Furthermore, the general safety regulations (SKIFS 2004:1) allow SKI a flexible approach with regard to review of modifications to the plants, safety cases and technical specifications. As described in the second report to the Convention (Ds 2001:41, section 8.5), the licensees have to notify SKI of such modifications. SKI has a procedure in place with specific criteria to assess the notifications and decide which are interesting enough from safety aspects to review. This system allows SKI to concentrate review resources on the most important safety issues.

Regulatory indicators

In order to further develop instruments to prioritise safety, SKI runs a pilot project on indicators since a few years. The aim is to provide additional insights to various inspection activities and to support the annual integrated safety assessments done by SKI of each major facility (SKI-Forum). The set of indicators has been modified as experience has been obtained.

The present set of pilot indicators has a hierarchy formed after data collection possibilities and in the future to facilitate aggregation of groups of indicators. For the time being the licensees provide data for the higher-level indicators (e.g WANO) and maintain a database on maintenance records. SKI derives the indicators based on LER:s and calculates unavailability. There are no threshold values linked to a certain SKI response. This might be considered later. Colour codes are only used for the large set of system unavailability with the purpose to alert SKI inspectors. The high-level indicators (level 1) were chosen because they are available. The lower level indicators (level 2) were chosen to provide more detailed insights into various safety concerns. A grouping into barriers and levels of the defence in depth were chosen to match the broad picture used in the integrated safety assessments and Swedish regulations, and thus to evaluate how well the utility operates and maintains equipment important to safety.

For the future, some indicators might be modified and additional indicators will be tested. Documentation will cover some years for trending purposes. When sufficient experience has been obtained, an evaluation will be done and a decision taken on the future use of indicators for regulatory purposes.

10.5 Conclusion

The Swedish Party complies with the obligations of Article 10.

11. Article 11: FINANCIAL AND HUMAN RESOURCES

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1. *Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.*
2. *Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.*

11.1 Regulatory requirements

In order to obtain a licence in Sweden, large economical resources must be committed in order to manage the far- reaching safety obligations required in the Act on Nuclear Activities and SKI regulations. Every presumptive licensee must be assessed in this respect. In addition to this basic requirement, licensees must pay a fee on every produced kWh to a state fund, the Nuclear Waste Fund, according to the Act on the Financing of Future Expenditures for Spent Fuel etc (1992:1537). This is to ensure the financing of decommissioning, handling and disposal of spent fuel and nuclear waste, including the research needed for these activities. The amount is calculated on an operating time of 25 years. In the event of a longer operating time, fees for the handling of additional nuclear waste will have to be paid, but all the fixed costs are included in the cost estimate for 25 operating years. In the event of an earlier shut down, the licence holders must provide financial security to the Nuclear Waste Fund[10].

Regarding human resources, the general safety regulations (updated as SKIFS 2004:1) are specific about the staffing and training of staff at the nuclear facilities. Long term planning is required of the licensees in order to ensure enough staff with sufficient competence for all safety related tasks. A systematic approach should be used for the definition of competence requirements, planning and evaluation of all safety related training. Annual competence assessments should be done. It is also a requirement that there is a careful balance between the use of in-house personnel and contractors for safety related tasks. The competence necessary for the ordering, managing and evaluation of the results of contracted work, should always exist within the organisation of a nuclear installation. For operations personnel at the nuclear power plants and research reactors there are specific regulations (SKIFS 2000:1, se section 7.2). These regulations also include operations managers and plant managers to the extent the latter involve in the operational decision-making.

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[10] The average fee for 2003 is 0.043 SEK/kWh. Required financial securities amount to 5,7 billions SEK. A special fee, at present 0.015 SEK/kWh, must also be paid for the handling of old nuclear waste in Studsvik.

11.2 Financial resources to support the safety of the nuclear installations

The majority owners of the Swedish nuclear power plants are Vattenfall AB and Sydkraft AB, with ownership shares as shown in figure 1 of section A 4. As mentioned there, the Swedish state is the sole owner of Vattenfall AB while the largest owner of shares in Sydkraft AB is the German utility E.ON.

Both the Vattenfall Group and the Sydkraft Group are financially stable and have good financial records. Some key figures from 2003 are given in table 8 below.

Utility group	Earnings MSEK[11]	Total assets MSEK	Electricity sales TWH	Equity/Assets Ratio %	Investments MSEK
Vattenfall	12 360	264 965	202.8	23.4	11 356
Sydkraft	3 578	81 811	30.1	38	16 493

Table 8. Financial records of the utility groups in Sweden. Note: The investments of Sydkraft are dominated by company acquisitions. Investments in tangible assets are 2.911 MSEK. The corresponding figure for Vattenfall is 8.554 MSEK.

After some years with low electricity prices, partly due to the deregulation of the market in the Nordic countries, prices have been higher in recent years, again increasing the competitiveness of nuclear power in Sweden. Utility profits have increased, and the economical provisions for investments in general have improved. The investment strategy that used to have priority on maintaining and enhancing safety of the plants, now seems to change towards broader and more long-term investment programmes for modernisation and availability improvements.

As an example, Vattenfall has recently taken decisions to invest approximately 18 billion SEK (about 2 billion EUR) to reach at least a 40 years life length in all nuclear reactors. Refurbishment of ageing components/systems accounts for 70 % and upgrading of safety and environmental standards due to new requirements for 30 %. The possibilities to reach longer life lengths and power upgrades are being evaluated. The goal today is to have life length investment plans for each generation unit, which is a higher ambition than five years ago.

11.3 Staffing and training for safety related activities at the nuclear power plants

Staffing situation

The Swedish operating organisations have always been considered small when compared with most other nuclear power plants around the world. The low number of staff has to some extent been compensated for by the use of a number of consultants and contractors, among these the original main vendors.

[11] Before taxes and minority share.

After deregulation of the electricity market, the traditional large use of consultants has been reduced, particularly those on long-term contracts. However, consultants are still being used when it comes to specific competence and during certain periods of time when the workload is too high on-site. This number of consultants today typically amounts to 20-50 per plant and year. A complicating factor in the continued use of consultants is that several with a genuine experience from the start of the nuclear programme, have now retired and are no longer available. The number of contractors used during a unit refuelling outage, normally lasting between 2-5 weeks, is as before between 500 and 1000.

The staffing and competence planning at the plants has been reinforced over the last years. The need for high-level competence in specific areas has been identified and competence profiles have been defined for all positions. By comparing these profiles with available expertise, the need for development and training of employees and for recruiting has been assessed. Several strategies are being used to transfer knowledge from the older to the younger generation, such as specific trainee programs and to involve young engineers together with highly experienced staff in modernisation and development projects as well as in international R&D projects.

The need to ”rejuvenate” the nuclear power plant organisations is obvious when regarding the age distribution figures shown in figure 5. Forsmark is probably the most favourable site from the age structure point of view, as it is the youngest of the four Swedish nuclear power sites, although differences are not that big. At Oskarshamn, where big effort is put on this issue, it has been identified that 145 individuals will retire within the next ten years. About 40 of these are considered having strategic competence. A specific plan based on the individuals’ competence has therefore been developed in order to deal with the transfer of competence. Similar efforts are made within the Ringhals group (incl. Barsebäck) with some 1500 employees. About 40 % are between 50 and 65 years of age and,

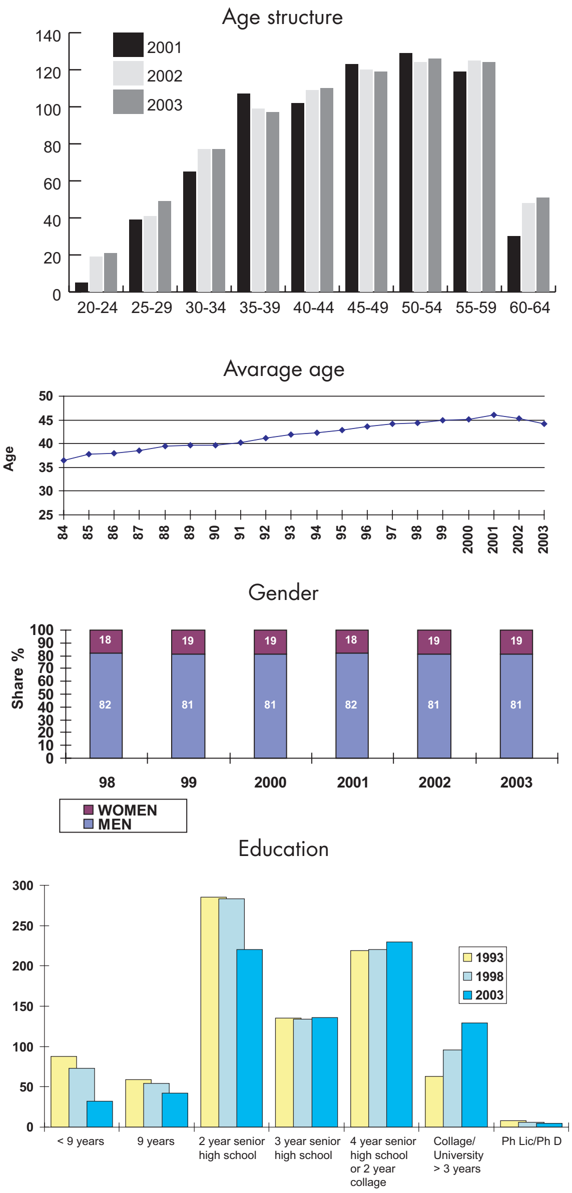

Figure 5. Staffing data from Forsmark NPP.

according to Ringhals' analyses, about 320 persons need to be employed during the next ten years.

In order to ensure the availability of resources and competence in the future, especially if the domestic reactor supplier Westinghouse Electric Sweden will downsize further, the BWR licensees have discussed the possibility to establish a jointly owned company for engineering and maintenance, like the jointly owned SKB and KSU. The utilities have the ambition to take over this responsibility, but a bigger body than a single utility is needed to accomplish this in an efficient way. However, no such agreement has been made so far. It also remains to be seen how the new Finnish reactor project will affect the market.

Training of nuclear power plant staff

The first report to the Convention described the organisation and structure of training at the nuclear power plants. This description is essentially still valid.

During the period 2000-2004, parts of the training organisations of the plants have been out-sourced to KSU. A relocation of several of the full-scale simulators to the sites has also taken place, including decentralised administration and training (see table 9 below). By the locally sited simulators and transferring of the nuclear power plant training organisation to KSU, several benefits have been achieved, such as better integration of the theoretical and the simulator training, more effective use of the simulators etc. The B1 simulator remains at the centralised training centre in Studsvik , due to the uncertainty regarding the future of Barsebäck 2, and the on-going development of an O2 simulator to be located in Oskarshamn. The FO3 simulator stays in

Simulator	Target unit	Taken into operation / relocation
B1	Barsebäck 1 and 2, Oskarshamn 2	1975
R3	Ringhals 3 and 4	1978 / 2001
FO3	Forsmark 3 and Oskarshamn 3	1984
F1	Forsmark 1 and 2	1990 / 2001
R1	Ringhals 1	1991 / 2002
O1	Oskarshamn 1	1993 / 2002
R2	Ringhals 2	1995 / planned for 2006

Table 9: Swedish fullscale simulators.

Studsvik as it serves Forsmark 3 as well as Oskarshamn 3. The R2 simulator will be relocated in connection with implementation of the TWICE project (see section 6.2). Hardware and software service, production of training materials and other common administration will remain at KSU in Studsvik.

11.4 Regulatory control

The compliance of the licensees with the SKI requirements on competence assurance was inspected a few years ago at all nuclear power plants. SKI has continued to follow up on these inspections and is now generally satisfied with the systems in place at the nuclear power plants to assure long term staffing and competence. Special inspections are recently being directed at training and competence assurance of operations personnel. Two plants remain to be inspected under this effort. SKI has concluded that competence assurance has received high priority by the licensees and that the required systematic approaches are in place.

11.5 Situation with regard to national supply of nuclear engineers and other qualified experts

In the first report to the Convention, concerns were expressed over the future supply of nuclear experts against the background of the general declining future of nuclear power in Sweden. The second report painted a more optimistic picture since there were agreements in place to support the university infrastructure for six years, with basic resources for education and research in key nuclear disciplines. It was also mentioned that there were no difficulties experienced so far to recruit the necessary technical staff to the nuclear power plants.

The government investigation of nuclear safety (mentioned in section 6.4) made a special assessment of the national situation with regard to access to nuclear and radiation protection competence. As mentioned, the investigator judges that the key nuclear competence will be sufficient for the next ten years to cover the national demands. In the longer perspective as more reactors are decommissioned and more approaching their technical end of life, there are reasons, in the opinion of the investigator, to closely monitor the situation.

The investigator shows more concerns about the situation in radiation protection, where higher education and research has decreased more over the last years and where no agreement is in place to support the universities. An increased number of adequately qualified radiation protection specialists will be needed as the nuclear power plants enter their decommissioning phase. There is however still time to improve the situation. It is suggested that the Government orders SSI to investigate the long-term needs for strategic national radiation protection competence and suggest measures in order to safeguard the necessary supply of specialists. Radiochemistry and radio-physics were especially mentioned as areas of concern.

The investigator made her judgement based on the SKI report to the Government on future research strategy (see section 8.3) as well as own investigations.

11.6 Conclusion

The Swedish Party complies with the obligations of Article 11.

12. Article 12: HUMAN FACTORS

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1 Regulatory requirements

The first report to the Convention contains a description of the initiatives taken by SKI, after the 1979 Three Mile Island event, to implement the concept of Human Factors, or MTO (interaction between Man-Technology-Organisation) as it is referred to in Sweden. Most of the initiatives regarding plant design, safety management and organisational issues, earlier discussed with the utilities, are now included as requirements in the general safety regulations (updated as SKIFS 2004:1), as mentioned in the second report. In general these regulations regard MTO-issues as equally important for safety as the technical issues.

In the updated regulations, the requirements on safety management have been further extended and made clearer. For instance it is now directly stated that nuclear activities shall be conducted with an adequate organisation having sufficient economical and personnel resources and being designed for maintaining safety. The adequacy of the organisation should be regularly assessed. It is also more emphasised that activities important to safety shall be monitored and assessed in a systematic way on a routine basis. Deviations shall be identified and handled so that safety is maintained and developed according to valid objectives and plans. Safety indicators are mentioned as a suitable tool for monitoring and follow-up.

Regarding assessments of organisational experience, safety culture surveys are recommended among other suitable tools.

12.2 Measures taken by the licence holders

Today the MTO concept has become an established component in the nuclear safety work of all Swedish nuclear power plants, supported by policies, responsibilities and organisational structures which differ between the plants and the different subject areas. A recent trend is that line managers and technical specialists at different levels of the operating organisations have received training and are more aware of these aspects than before. This in turn has to some extent reduced the use of MTO specialists.

R&D projects

As also reported previously, several R&D projects have been conducted to support MTO-activities at the plants. Since 2001 the following major new project has been launched: LearnSafe.

LearnSafe, an EC-sponsored project with the main objective to create methods and tools for supporting processes of organisational learning at the nuclear power plants. Organisational learning has become increasingly important for the nuclear industry in its adaptation to changes in the political, economic and organisational environment. The danger during a rapid process of change is that minor problems may trigger a chain of events leading to actual degrading of safety and/or diminishing political and public trust in the safety standards of the particular plant, utility or corporation. The focus of the project is senior managers at nuclear power plants and power utilities who are responsible for strategic decision-making and resource allocation. Project results will include recommendations and inventories of good practices. The final report will be available during 2004.

Current developments

Within the frame of the MTO/Human Factors concept various measures have been taken to promote safety in Swedish nuclear power plants. The following provides some examples of ongoing activities at the Swedish nuclear power plants.

More emphasis has been focused gradually upon management and organisational issues as important areas for application of the MTO-concept. Especially assessment of organisational changes has developed over the last years as a result of the changing external environment for nuclear operations. All licensees have introduced formal procedures for assessment and review of organisational changes. These procedures secure that all relevant aspects are taken care of when it comes to the potential impact on safety, i.e. that such changes are reviewed, and reported to SKI in the same manner as technical changes.

Safety culture questionnaires are now used regularly at all plants, and are seen as an important tool for development of the safety culture. The questionnaires have a high answering frequency. The 2003 questionnaire was answered by 95 % of the personnel at Ringhals and Barsebäck. The answers are compiled and reported enabling departments and groups to compare their results with other organisational units and previous results. Changes observed are then discussed in groups, and action plans to improve are decided upon. Some plants use the results from the safety culture questionnaire as a safety indicator.

For the Ringhals Group, the safety culture work is described in a 4-year programme that is updated once a year. This programme contains planned activities for different levels of the organisations. Ringhals is also developing a classification system to assess MTO root causes behind events occurred. A system for integrated, systematic handling of deviations is to be implemented during 2004. It will provide a tool to analyse various failures to find common root causes, and thereby enable elimination of such events. It categorises MTO related events based on what happened and why it happened, and will also be used for operating experience feedback.

Ringhals has developed its MTO abilities through a new organisation. There is one fulltime co-ordinator employed, and a working MTO steering group with seven members. Approximately 40 people within the Ringhals Group have received basic education about investigative MTO methodology. When needed, and to promote experience feedback, such resources are also brought in from other nuclear plants.

Forsmark has developed a tool (named TIGER) for evaluation of plant changes affecting interactions between technical systems and operators. The tool is based on US and other international guides and results in ergonomically optimal designs.

A project for development of methods for diagnosis of the robustness of the organisation and management systems for nuclear safety has been performed by OKG. The method aims at identifying and evaluating six important basic safety activities that need to function properly in order for a nuclear power plant to be run safely. The basic activities are evaluated by judging the standard of the sub activities that together make up each basic safety activity. Each sub activity is evaluated by judging the standard of 22 different evolution areas, i. e. depth, integrity, experience, resources, etc.

Projects have been performed in co-operation with University of Stockholm and University of Linköping, e.g. one investigating non-destructive testing from a human factors perspective and another analysing operability verification in a MTO perspective.

Interestingly, knowledge and methods from the development of the MTO concept within the nuclear sector has had rather strong impact on safety development in other activities, such as general industrial safety, patient safety, transportation and offshore sectors.

12.3 Regulatory control

As reported in the second national report, the MTO-department of SKI participates in inspections, safety reviews and other regulatory activities completely integrated with the technical departments. Five professionals with a behavioural science background work at the MTO-department.

Current issues for the department are inspection and review of

- Plant modernisation projects, especially new digital I&C applications and upgrading of control rooms
- How the licensees monitor and assess their safety culture and use the results
- Management systems including staffing and competence for primary and independent safety review
- Organisational changes
- Staffing, training and competence assurance

Current regulatory research initiated by the MTO-department includes projects on

- Safety culture assessment
- Economy systems and control in order to assure safety
- Annunciator presentation systems for control rooms
- Safety management
- Operability verification
- Inventory of supervision strategies used by other authorities

- Inventory of maintenance strategies

Except these R&D projects, SKI supports one professorship in Man-Technology-Organisation at the Stockholm University and several post graduate studies. SKI also supports the Halden Reactor Project since many years.

12.4 Methods to assess organisational change

At the second review meeting Sweden was asked to present in its next national report the development of methods to assess organisational change from the safety point of view, and results gained from such review. The following is an update of this situation.

According to the general safety regulations, the licensees are obliged to notify SKI about organisational changes of principal importance for safety, before they are implemented. SKI can then put additional conditions and requirements on the proposed change. Over the last years SKI has received a relatively large number of such notifications. They have dealt with implementation of new concepts for control of plant activities, centralisation, de-centralisation, outsourcing and downsizing of various plant functions. The quality of the notifications and the associated licensee safety reviews has varied.

When SKIFS 1998:1 went into force 1999 with the mentioned requirement to assess, develop a safety case and notify SKI about organisational changes, it was not clear to the licensees and SKI how to do this. Over the years a practice has developed and the notifications today have a good quality in general.

The SKI review focuses on the licensee's own process in order to assess and control the organisational changes.

Based on domestic and international experience, SKI has identified a number of factors or aspects that the licensees should consider when planning an organisational change. These factors should be possible to identify in the safety documentation accompanying a notification to SKI:

- An assessment of strengths and weaknesses with the present organisation
- Clearly described purposes and objectives of the change
- A description of how the proposed change will be managed
- A description about how experience on similar changes have been considered
- An analysis of the safety consequences of the change
- The implementation plan for the change
- Plans for evaluation and follow-up of the change
- Statements of the primary and independent safety review
- How finding from the safety reviews have been taken care of
- Needs for revision of the safety report (SAR)

SKI has found that the licensees today have developed adequate procedures for dealing with organisational changes along these lines and that they generally use experiences gained at own and other plants. Problems are related to underestimation of the time needed in connection with a larger organisational change, to assess the impact of the change on the management system with associated instructions, and to revise necessary parts of the documentation. There are however, positive examples of safety assessments of what docmentation must be revised as a priority. SKI has also found that successful implementation of a matrix organisation, i.e. a combination of different organisational principles, for instance combining a functional organisation with a project organisation, requires large preparations. Responsibilities, roles and interfaces must be made clear, in advance of implementation, to all personnel involved, and the change must be closely evaluated and followed up in order to avoid role-diffusion with negative consequences for safety.

SKI will continue the development of methods to assess organisational change and is active in the international co-operation addressing this, for instance within the NEA/SEGHOF.

12.5 Conclusion

The Swedish Party complies with the obligations of Article 12.

13. Article 13: QUALITY ASSURANCE

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation

13.1 Regulatory requirements

Since the second report to the Convention SKI has further developed its requirements on Quality Assurance. The requirement on the licensees to use a quality system for controlling all safety related activities, has been revised in line with the international development in this area. In the updated general safety regulations (SKIFS 2004:1) it is required that nuclear activities shall be managed, controlled, assessed and developed through a management system in such a way that requirements on safety are fulfilled. This view on quality and safety to be integrated in a total management system, is in line with the ongoing development of the IAEA QA-standards to become a new series of standards named Management Systems for Safety. It is also in line with the recent ISO 9000:2000 standards. Safety shall be considered in the management of all relevant plant activities and not seen as a separate responsibility for a safety department or in connection with certain issues only.

It is also made more clear in the revised regulations that the management system must be clear about how to audit contractors and vendors, and how to keep results form these audits up to date. It has become more common that the licensees buy a total functional solution, which is delivered ready to use. In these cases it is especially important that the licensee makes sure that the vendor is delivering the right quality.

13.2 Measures taken by the licence holders

Management systems

During the last years considerable work has been done at the Swedish nuclear power plants to develop their quality systems to become an integrated part of the total management system of each plant.

As a consequence of the formation of the new Ringhals group, Ringhals and Barsebäck had to modify their existing systems towards a common management system structure. Documents of those systems are divided in 5 different groups:

- Class 1 documents are related to highest-level management, the Ringhals group overall management system. The documents include directives to all departments and staff units at both plants. The plant manager owns the class 1 documents.

- Class 2 documents include those related to plant configuration such as requirements, realisation, inspection, testing, operation and maintenance. The respective production manager owns the class 2 documents
- Class 3 documents include such that govern the processes, i.e. process handbooks, instructions, reports, letters etc. The respective process owner owns the class 3 documents.
- Class 4 documents include such related to individual department internal activities, i.e department handbooks, procedures, reports, protocols, letter of assignments etc. The respective department manager owns the class 4 documents.
- Class 5 documents include those related to project activities such as administrative documents which are created and belongs to the projects, i.e. reports, protocols, time schedules etc. The respective process owner owns the class 5 documents.

OKG has also restructured its quality system. The new integrated management system consists of three top documents, which contain basic quality requirements for steering of all activities within the company, i.e. the OKG vision, policies, strategic plan, delegations and descriptions of company activities and organisation. All personnel have been educated on the new system.

OKG, as well as the Barsebäck plant, received an environmental certification in 2002 according to the standard ISO 14001. As the radiological issues were already well taken care of, the focus of the efforts to get the certification was on conventional environmental protection. Forsmark and Ringhals have received environmental certifications earlier.

The Forsmark quality assurance programme has developed into a fully integrated management system comprising quality, environment and industrial safety. The internal audit programme does also reflect this integration.

Audit programmes

Every Swedish nuclear plant has developed a quality audit programme, which is utilised to monitor how well the quality system is implemented and applied in the organisation on different levels, as well as the efficiency of the system to ensure quality and safety. Such quality audits are performed on a regular basis, so that all areas are covered during a four-year period. Audit teams consisting of 3-4 individuals, experienced in the reviewed area, and an audit team leader, perform normal quality audits.

Since 1999, Ringhals uses process audits with the same concept as WANO Peer Review (10-12 individuals divided into sub teams) in the audit areas Operations, Maintenance and Engineering & Modification. The audits also include industrial safety and environmental issues.

Quality audits of suppliers

The common routines used by the Swedish nuclear plants for supplier audits were described in the first national report. A new agreement on co-operation between the plants was signed in 2003.

13.3 Measures taken at SKI and SSI

See section 8.4.

13.4 Regulatory control

As mentioned in section 13.3 inspection and review of the licensee management systems is one priority for the SKI MTO department. These reviews are more or less constantly ongoing, since the scopes of these systems are broad and many changes are made. The new system developed by the Ringhals Group mentioned above has been comprehensively reviewed and received good assessments by SKI. At present the OKG Management System, modified after an organisational change, is under review.

In order to inspect and review management systems in a systematic way, it has been necessary for SKI to develop a checklist on the essential aspects to assess. This list covers the SKI requirements as well as recommendations given in the IAEA Code and Safety Guides on Quality Assurance (Safety Series No 50-C/SG-Q. Vienna, 1996). The checklist will be updated according to the new IAEA standards on Management Systems for Safety.

13.5 Conclusion

The Swedish Party complies with the obligations of Article 13.

14. Article 14: ASSESSMENT AND VERIFICATION OF SAFETY

Each Contracting Party shall take the appropriate steps to ensure that :

(i) Comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body.

(ii) Verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

14.1 Regulatory requirements

Requirements on safety assessment, safety review and the safety report are collected in a separate chapter (chapter 4) of the new general safety regulations SKIFS 1998:1, updated as SKIFS 2004:1. These requirements were comprehensively described in the second report to the Convention. In the updating of the regulations, the following has been added or clarified:

- It has been made clear that safety analysis using probabilistic methods is a generic legally binding requirement in addition to deterministic analysis. For nuclear power plants, a full PSA level 1 and 2 is required as already stated in SKIFS 1998:1. In the general recommendations to the regulations, some advice is given on the acceptability of using probabilistic arguments when proposing plant modifications.
- It has been clarified that the safety report (SAR) shall reflect the plant as built, analysed and verified and show how the valid safety requirements are met. Plant modifications shall be assessed against conditions described in the SAR. It has further been clarified that all plant structures, systems and components of importance for the defence-in-depth shall be described in the SAR, not only the safety systems. New safety standards and practices, which have been assessed by the licensee and found applicable, shall be documented and inserted into the SAR as soon as corresponding modifications or other plant measures have been taken. A few additional requirements on the contents of the SAR have also been added.
- The requirements on Periodic Safety Review have been made more stringent in order to use these reviews for assessment of time limited licensing conditions (see also section 6.2). This means that the Swedish approach to PSR becomes more in line with the European approach, where PSR is often used in the relicensing of the nuclear power plants. 15 safety areas are now explicitly mentioned in the Swedish regulations where the plant shall be assessed with regard to valid regulations, licensing

conditions and applied safety standards, as well as against applicable new safety standards and practices. Any deviations shall be assessed in a stringent way from the safety point of view, and corrective measures prioritised. All deviations from valid requirements shall be corrected without delay. Reasonably practicable measures shall be taken to comply with applicable new standards and practices, and be included in the plant's safety programme.
- Extended general recommendations have been added on what to include in the specific two-fold safety review, primary and independent, that is required to be submitted to SKI in connection with a notification of a plant modification, a principal organisational change or modification to the SAR or Technical Specifications.
- Requirements on maintenance, surveillance and testing have been amended with a requirement on an Ageing Management programme. This programme should include identification, surveillance, handling and documentation of all ageing mechanisms, which could affect structures, systems and components of importance for safety. Individual measures included in such a programme are already required according to existing rules, but it will now be required that these measures are integrated in a consistent programme within the plant's management system. The licensees are given one year to develop these programmes.

Further regarding the requirements on surveillance and testing, several new general recommendations have been added about the conduct of functional testing in order to promote more stringent and extensive practices. The licensees have flexibility here, to take the measures as recommended or to implement another solution, which can be justified to be equal from the safety point of view.

As mentioned in section 7.2 specific regulations (SKIFS 2000:2) exist on mechanical components in nuclear installations dealing in particular with design, recurrent testing and surveillance and conditions for the repair of such components.

14.2 Measures taken by the licence holders

In the first report to the Convention, there is an extensive section about how the requirements are met by the licensees. An update was given in the second report. Most of the earlier reports are still valid, the following focuses on the current developments:

Safety reports and safety assessment

With regard to PSA and risk informed applications, the following is currently ongoing

- The deterministic safety reports (SAR), which have been updated after the design reconstitution projects, are verified by use of PSA.
- Several extensive PSA-studies have been performed, or are underway for the Swedish reactors. The

current situation is summarised table 3 in section 6.2.

- There is an ambition to develop PSA into a tool for daily safety considerations via various projects. So called living PSA applications include the PSA to be periodically updated, at least once a year with regard to plant changes affecting the PSA-model.
- Coordination of R&D efforts between the plants and SKI has continued via the PSA Nordic Owners Group.
- PSA analysis is today implemented in regular quality routines, such as the safety review processes.

For the three PWR units in Ringhals, an extensive project has been performed during the last three years including new or updated level 1&2 analyses for power operation, shut-down/hot stand-by/start-up, CCIs, fire, flooding and all external events except seismic.

Ringhals unit 1 has undergone an extensive level 1 update, and is planning for a level 2 update, integration of the level 1 and level 2 analyses, and updates of the fire and flooding analyses. For the planned modernisation of the reactor protection system, a flexible level 1 model will be used during the design.

A common project for all units at Ringhals is "Streamlined Reliability Centred Maintenance", SRCM, a system to be combined with traditional maintenance methods. The project was started in 2003 and is planned for completion in 2006, and will be beneficial for reactor safety, as it will evaluate all equipment affecting safety.

RIVAL is a methodology for risk-informed in-service inspection that was described in last report. Methods have now been developed and sent to SKI for review.

In Forsmark, in addition to an ambitious PSA updating programme for all three units, development is performed to use PSA models in investment analyses for balancing safety and economy. A development project is also performed on maintenance methodology, based on simplified theoretical RCM models, aiming at practical application.

For Barsebäck 2 a major updating project of level 1 and level 2 PSA, including merging of the two models into one common model, has recently been completed. Analyses of low power operation and cold shutdown are to be completed in 2004. An ongoing development project is to evaluate the safety impact of allowed outage times and test intervals. The intention is to build a basis for future changes to technical specifications. Barsebäck is also during 2004 performing a test of a risk monitor to become an efficient tool for short-term and long-term safety analysis. It will also help to build a broader PSA competence.

Oskarshamn has performed analyses of low-power and shutdown modes of operation for units 2 and 3.

In line with the updated SKI safety regulations (SKIFS 2004:1), the deterministic safety criteria and analysis will continue to serve as the licensing basis for design and construction. PSA methodology in various risk-informed applications is being used, and will be to an increasing extent as a complementary tool in the plants modernisation work.

International Safety reviews

See sections 9.2 and 10.2

A common structure for safety management and review

Vattenfall has found that experience gained from a number of events in recent years revealed the need for a revision of the processes for safety review. A common structure for safety management and review has therefore been introduced for all the Vattenfall nuclear power plants: Ringhals, Barsebäck and Forsmark, aiming at an increased robustness and company transparency in the processes for safety review.

The plant manager, as formally representing the licensee and being the prime responsible for safe operations, is requested to have a well structured model for safety assessment and review, including a firm decision making structure. In the Vattenfall model, the plant manager executes a two-folded safety review fully in line with the regulatory requirements.

The first review is conducted through the responsible line organisation, within three defined levels of responsibility and authority:

- Safety oversight level 3 (DL3) is represented by the operations department manager and responsible for safe operation within the limits of procedures and technical specifications. DL3 is also responsible for all work permits on safety related equipment. Safety related deviations should be reported to DL2.
- Safety oversight level 2 (DL2) is represented by the production unit manager, and responsible for long-term safety issues, manuals and procedures. DL2 is also responsible for the unit related safety review. Additionally DL2 has to ensure that the unit safety report (SAR) is up to date and reflects sound safety practices. DL 2 shall follow up on deviations, trends and operating experience. Deviations from regulations, company norms and policies should be reported to DL1. DL2 shall also sanction routines for and extent of work on safety related equipment, and ensure that documentation fulfils the requirements.
- Safety oversight level 1 (DL1) is represented by the plant manager. DL1 is responsible for the overall safety review process, and for specific safety issues forwarded to him from lower levels (DL2 and DL3). DL1 responsibility includes issuing of policies, the safety management system and company directives for nuclear safety, as well as sanctioning deviations from those.

The second review is the independent safety review managed by the department of Safety & Compliance. In principle, both reviews cover the same areas of competence, but the latter does not require the detailed review of numerical analyses. Similar types of competence are required, but the department of Safety & Compliance is expected to be staffed by senior people with long experience.

When the plant manager takes decisions on important safety issues, or principal matters such as restart of the plants after outage, plant modifications in safety related equipment, etc. he must consult and ask for advice from the company safety review committee.

The common Vattenfall structure also outlines:

- Reporting criteria and requirements
- Criteria for periodical (daily and weekly) operational meetings including criteria regarding shift change-over
- Issues to be handled within the company safety review committee
- Requirements regarding plant modifications (technical and organisational)
- The kind of forums needed to deal with principal long-term safety issues (at plant and corporate levels).

14.3 Regulatory control

As mentioned in the second national report, SKI had since SKIFS 1998:1 came into force 1999 inspected the safety review organisations and procedures at all nuclear sites. The conclusions of SKI from those inspections were that requirements on documentation of the new procedures were not fully met. Since then the licensees have established their safety review procedures and the system with primary and independent safety review is mostly running to the satisfaction of SKI. An ongoing issue is the staffing and competence requirements on the independent review functions, where SKI has some remaining remarks to be addressed by some of the licensees.

As mentioned in section 6.2, SKI has reviewed the newly submitted revised SARs and has concluded that the reports submitted so far constitute substantial improvement. Remaining updated SARs are soon expected for review as well as modifications to SARs already submitted.

Review of updated and extended PSAs is a heavy ongoing task for SKI. Several projects are expected for review in the near future (se sections 6.2 and 14.2). SKI is concentrating its review on the overall quality of the submitted PSA studies. Some detailed review samples are taken by use of consultants, but SKI has no intention to penetrate the studies in detail.

Inspection and review of in-service-inspection programmes and activities and conduct of other surveillance activities, have been inspected during the last years in connection with broad inspections of safety management at all plants. Detailed review of design specifications, design calculations, welding procedures, manufacturing procedures and also observation of these activities, is done by accredited inspection bodies. In addition there is an independent NDT Qualification body. This body qualifies NDT-systems that are to be used for in-service-inspection, as required in SKI regulations SKIFS 2000:2.

As extensively described in the second report to the Convention, the licensees have to notify SKI of all plant modifications affecting conditions reported in the SAR, as well as modifications to the SAR itself and Technical Specifications. A standing group of experts, from different SKI departments, has been established in order to make a first assessment of all notifications. The group makes a proposal to the reactor safety management meeting regarding each notification:

- no further action, or
- the notification should be further reviewed in specified aspects
- the proposed modification shall not be allowed until SKI has reviewed the documentation.

For this first assessment, a set of criteria has been developed on the safety significance of the notification, other relevant circumstances, and the degree of confidence SKI has in the self-inspection of the licensee. For instance, if a notification has to do with new or complex technology, is of high safety significance or confidence is low, there is a high probability that this notification will be reviewed further. The office head makes the final decision whether to review or not.

SKI now has five years of experience with this model. After some initial problems, it can now be concluded that the notification routines are running smoothly and meet the expectations of SKI. It is also clear that SKI has the necessary regulatory control of the modifications, without having to review everything in detail and issue approvals. In that way resources can be released for other important safety tasks.

In year 2000, a total of 230 technical, organisational and documentation change notifications were submitted to SKI. 53 of the notifications resulted in a review by SKI. Corresponding figures for 2003 are 215 notifications of which 41 were reviewed further. In about half of the reviewed cases SKI imposed further conditions on the modifications, and in a couple of cases SKI halted the implementation of the modification until further investigations could be made.

14.4 Conclusion

The Swedish Party complies with the obligations of Article 14.

15. Article 15: RADIATION PROTECTION

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonable achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

15.1 Regulatory requirements

Occupational radiation protection

Since the first and second report to the Convention, some of the SSI regulations on radiation protection have been revised and a few new have been added. Today there are 49 regulations in force covering most areas where radiation may occur (see an overview in section 7.2).

The Swedish radiation protection requirements aimed at the nuclear power plants are similar to those of other EU countries. The most important requirements (included in SSI FS 2000:10 and 11) are the following

- Optimisation
  The work shall be performed in such a way that human exposures are limited as far as reasonably achievable, social and economical factors being taken into account. For this purpose the licence-holder shall ensure that goals and actions necessary for control are established and documented and that necessary resources are available.

- Information and education
  All personnel, permanent staff and contractors, shall be informed about radiation protection prior to work within a controlled area. Repetitive information shall be given at least every third year.

- Medical examination
  Medical examination for radiological activities is required every three years.

- Site-specific instructions concerning radiation protection
  The licence-holder shall ensure that site-specific instructions for radiation protection are established.

- Controlled areas
  Within a controlled area, premises and places shall be especially marked and admittance restricted, if the risk of receiving a yearly effective dose exceeding 50 mSv in these places is not negligible. Smo-

king and consumption of food are forbidden in controlled areas.

- Visitors
  Visitors by the general public in a controlled area may only be permitted if guided by a responsible person and if a prearranged plan is followed. Visitors to controlled areas must be at least 14 years old.

- Personal dose monitoring
  All personnel including external workers shall within a controlled area carry an individual dose meter meeting certain requirements and shall undergo contamination checks before leaving the area. If there is reason to suspect that individuals have been internally contaminated, or if internal contamination is confirmed, all such individuals shall undergo whole body counting.

- Instruments and equipment
  All instruments used for radiation protection and the control of radiation doses shall be calibrated and undergo regular functional checks.

- Transport within the facility
  All transportation within the industrial area shall, as far as is practical, be in accordance with the regulations on the transport of hazardous goods on roads with regard to the requirements on dose-rate, surface contamination or the transportation package.

- Work with irradiated fuel elements
  Work with dismantling irradiated fuel elements in the reactor pool, where single fuel rods are handled, must not take place earlier than five days after the reactor is put into the cold shut down mode. During work with fuel rods only persons directly involved in the work may be present. Air monitoring shall be performed continuously during the work at the working position for fuel dismantling. Documented instructions for alarms and evacuation of the premises shall be available. The instructions shall be well known by all persons working on the premises.

- Policy in the event of fuel damage
  A documented policy for the event of fuel damage shall be established at all facilities where nuclear reactors are involved. The policy shall include a description of the facility's strategy for avoiding fuel damage as far as reasonably possible. In addition there shall be a strategy for how to handle a situation if fuel damage occurs.

- Reporting to SSI
  An annual written report shall be sent to SSI that contains a compilation of the radiation doses to personnel as well as the results of the radiation surveillance outside the controlled area. Any work for which the total collective dose is expected to exceed 100 mmanSv shall be reported in writing to

SSI in advance. No later than 3 months after the work for which the total collective dose has exceeded 100 mmanSv is finished, a written report shall be sent to SSI that includes the experience obtained concerning radiation protection matters.

Any internal contamination occurring, in one single event, which is calculated to give a committed effective dose exceeding 5 mSv shall be reported to SSI. The report shall comprise the type of intake, the estimated committed effective dose and the basis for those calculations, as well as the cause and circumstances of the internal contamination. The report shall be sent as soon as possible after the contamination has been discovered.

If there has been an event that has implied, or could have implied, that any given dose limit (SSI FS 1998:4) is exceeded, a report shall be sent to SSI promptly.

- Documentation and filing of measurement data
  Primary data on the evaluation of individual radiation doses due to external as well as internal exposure shall be kept at least one year after the calendar year in which the measurements were made. From the final results of these evaluations it shall be possible to correlate a measured dose to the person that received that dose. The final results shall be available in a central national dose register that is approved by SSI.

- Radiation protection manager
  The licensee shall appoint a radiation protection manger. This person shall be approved by SSI and have sufficient competence in matters related to radiation protection

Environmental radiation protection

New regulations (SSI FS 2000:12) on protection of human health and the environment from discharges of radioactive substances from certain nuclear facilities entered into force on 1 January 2002. These regulations apply on nuclear power reactors, research reactors, fuel fabrication facilities, storages for spent fuel and waste disposal facilities during their operational phase (shallow land burial sites are excluded). The most important provisions are the following

Dose constraints and critical group

According to the earlier regulations the dose limit for members of the public was 1 mSv per year from all contributing artificial radiation sources. This limit is also in accordance with EU BSS. Taking into consideration that an individual may be affected by dose contributions from more than one facility/source, a dose constraint for a particular site is set to 0.1 mSv per year in the new regulations. The licensee has to show that the doses from discharges are below 0.1 mSv per year to the most affected individual. When taking into account that some of the radionuclides will be present in the environment for a long time, it is important to compare the dose constraint of 0.1 mSv with the dose commitment from a yearly discharge, rather than with the dose from the discharge. SSI has chosen to set the integration time to 50 years when calculating the dose commitment. When the calculated dose is 0.01 mSv or more per calender year, realistic calculations of radiation doses shall be conducted for the most affected area. These calculations shall be based on measured dispersion data and knowledge within the most affected area.

Discharge limits

SSI has formally defined no nuclide specific discharge limitations. Limitation is being implemented through the restriction of dose to the critical group. Thus, for each nuclear facility and for each radionuclide discharge, site-specific discharge-to-dose values have been established. These values have been calculated for hypothetical critical groups, and take into consideration reasonably realistic local dispersion conditions, as well as assumptions on diet and the contribution of locally produced foodstuff to the diet of the group.

Previously emissions to air of C-14 and tritium have not been measured routinely. Emissions of C-14 have been estimated on the basis of international experience and calculated as 0.2 TBq GW per year for pressurised water reactors (PWR) and 0,6 TBq GW per year for boiling water rectors (BWR). However, the new regulations state that all nuclides should be measured.

Use of best available technology

The best available technology (BAT) shall be used for monitoring all discharges at nuclear facilities. However, for nuclear power reactors, in particular, a new concept, reference and target values, has been introduced.

A reference value is a value for the release of individual radionuclides, or groups of radionuclides that indicate the optimal operation of the reactor in terms of performance and management of systems of importance for the generation, elimination or delay of discharges into the environment. Nuclide(s) should be chosen on the basis of, e.g., impact or indicative function for system performance. The operator is responsible for formulation of reference values for a specified time, and they are to be reviewed by SSI.

A target value will define the ambition by the operator in terms of discharge limitation, taking into account, inter alia, BAT. The target value is to be defined by the operator, as well as the time frame within which the operator plans to reach the target.

The discharge of radioactive substances to the environment shall be measured. In particular, discharges to the atmosphere via the main stacks of nuclear power reactors shall be controlled through continuous nuclide-specific measurements of volatile radioactive substances such as noble gases continuously collected samples of iodine and particle-bound radioactive substances, as well as the measurements of carbon-14 and tritium.

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

Environmental monitoring shall be conducted in the area surrounding a nuclear facility in accordance with a programme formulated by SSI.

According to the regulations, quality assurance and documentation of environmental monitoring shall be provided in accordance with the principles of the ISO 9000.

Reporting

The nuclear power reactor licensees shall report to SSI annually the measures that have been adopted, or values witch are planned to be adopted by the licensees, to limit radioactive releases with the aim of achieving the specified target value. If reference values are exceeded, the measures that are planned to achieve the reference values shall be reported.

Releases of radioactive substances to the air and water as well as results from environmental monitoring shall be reported semi annually to SSI. The report concerning the second half of the year shall, at the same time, constitute the annual report.

Events leading to increased releases of radioactive substances from nuclear facilities shall be reported as soon as possible to SSI, describing the measures adopted to mitigate the releases.

15.2 Measures taken by the licence holders

The two earlier national reports include descriptions of the measures taken by the licensees to comply with the radiation protection regulations. The following concentrates on the current situation

The organisation of radiation protection at the nuclear power plants

The organisation of Radiation Protection (RP) resources are now centralised at all Swedish nuclear power plants, for Ringhals and Barsebäck as a common service function for both plants. Normally though, some individuals are still tied to specific units. External RP resources are hired when needed, particularly during the refuelling outages. Hired RP resources could then be as high as 70-80 % of the total demand during a refuelling.

Internal procedures for radiation protection

No fundamental changes have taken place within this area, but procedures are updated continuously due to changes in SSI regulations, organisational changes or internal experiences.

The introduction of the common management system for Ringhals and Barsebäck in 2002 has led to harmonised procedures, ambition levels and ways of performing work in the RP area. In Forsmark there is a trend towards the main RP procedure covering several additional areas, i.e. radioactive waste and handling of samples. Currently the unit specific procedures are also being included in the main procedure.

System radioactivity control

As a complement to periodic measurements of activity build-up and dose-rates in various reactor systems, four of the Swedish reactor units, Barsebäck 2, Ringhals 1, Oskarshamn 1 and Oskarshamn 2 now have on-line activity measurement systems installed in order to measure the activity in the reactor water. The measurement is nuclide-specific and allows the operators to follow the response and the transients in the reactor water when injecting, for instance, hydrogen and/or zinc, which are used for keeping the oxygen content in the reactor water at a low level and reducing the dose rates respectively. On-line dose rate measuring at several places, primarily in reactor water-cooling and clean-up systems, is applied at more reactor units in order to follow the dose rate situation continuously.

In Forsmark all units perform on-line nuclide-specific gamma measurement, mainly aimed as a tool for early detection of fuel failure. There is no zinc injection in the Forsmark reactors.

Dose reduction and implementation of ALARA programmes

The following are examples of measures, which have been taken or initiated during recent years, for reducing the dose rates in the plants, and consequently also the collective radiation doses

- The zinc injection method introduced in Barsebäck five years ago has now been evaluated. Build-up of activity in piping that was decontaminated or replaced by new piping in 2002 has been reduced by 30-50 %. Zinc injection also adds to the protection against IGSCC by HWC. Follow-up of zinc-injection introduced in 2003 is currently also being performed in Oskarshamn units 1 and 2.
- Forsmark 3 has performed a partial decontamination in the residual heat removal and core spray systems in connection with piping replacements in 2001. In 2003 the recontamination was shown to have been reduced by 50 %.
- OKG has performed system decontaminations ahead of major work in the primary systems. As an example, during the first stage of Oskarshamn 2 modernisation, project PRIM approximately 2,5 manSv were saved.

- Replacement of valves to such without the cobalt-containing stellite is done at the plants in parallel with other work performed on the valves.
- The Oskarshamn and Forsmark projects "Clean systems" aim at preventing foreign material intrusion, an important factor to keep doses low as it decreases the risk for fuel failure.
- At all plants, a policy for management of fuel failure has been issued that gives guidance on when to stop the reactor for fuel replacement
- Forsmark has established an ALARA group that meet 3-4 times per year to evaluate and develop the ALARA programme. One recent development is to concentrate more on individuals with yearly doses of more than 10 mSv.
- Ringhals is currently developing new methods for cleaning water-borne activity and conventional chemicals from different sources

Environmental radiological surveillance

After new stricter requirements from SSI concerning the measurement of tritium and C-14 in the release paths through the ventilation the Swedish nuclear power plants have in 2002 installed advanced specific equipment for such measurements.

15.3 Environmental impact of the Swedish nuclear power plants

Worker protection

After a decade, the positive results of the combined actions from the SSI and the Swedish nuclear industry can be observed. Occupational doses have decreased and the radiological environment in the reactors has improved. Figure 6 shows the development of collective radiation doses at Swedish nuclear power plants during 1992-2003. As can be seen in the figure the collective dose has decreased from about 20 manSv in the beginning of the 90's to about 10 manSv in the last five years. It is the view of SSI that the occupational doses, today and during the passed years, would have been higher if no counteractions had been introduced in the beginning of the 90's. The average individual dose has in the same time interval decreased from 3-4 mSv/year to about 2,5 mSv, as can be seen in table 10.

The increase in radiation levels (apart from re-oxidation of contaminated surface layers) was generally stopped and in some plants lower levels were achieved due to the efforts to reduce the production and distribution of Cobalt 60. Low contamination levels and improved work procedures are also reflected in the low number of reported intakes of radionuclides. The number of reported intakes (leading to a committed effective dose larger than 0,25 mSv) is presently 1-2 per year.

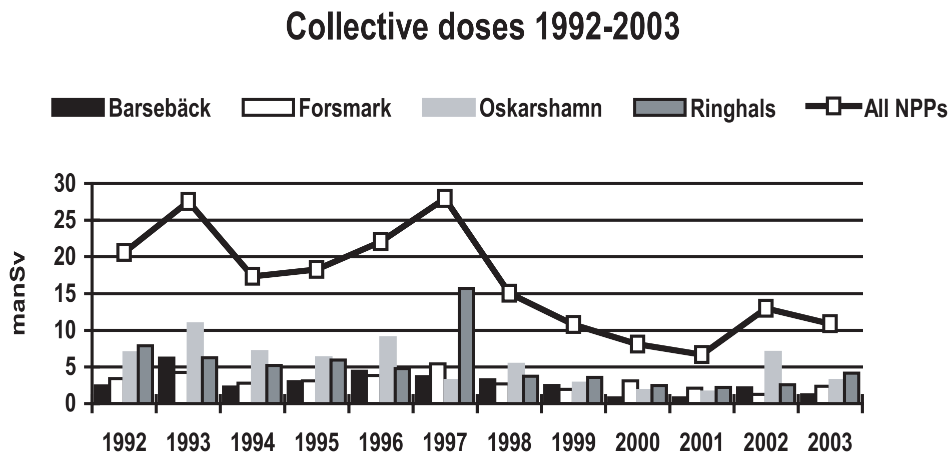

Figure 6. Collective doses at Swedish NPPs during 1992-2003. Major modernisation work was performed in campaigns 1993 and 1997 as can be seen in the two peaks in the diagram.

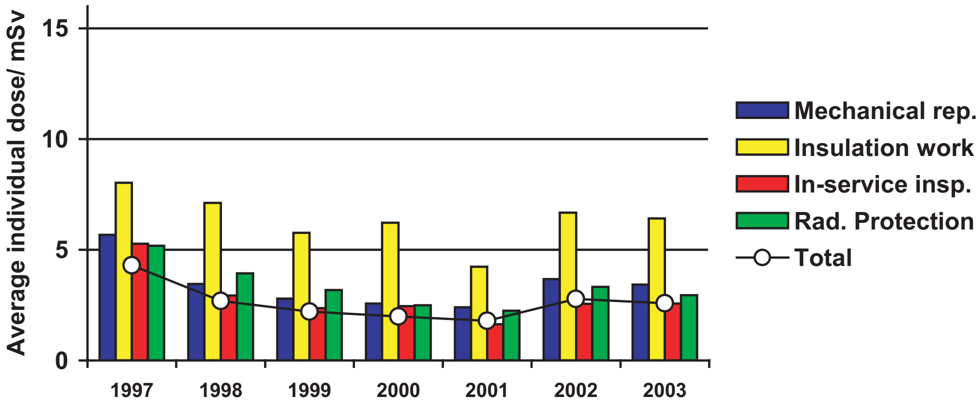

Figure 7. Average individual dose to some different categories of workers.

Year	Total dose (manSv)	Average dose (mSv)	Number of persons with dose >20 mSV
1997	27,9	4,3	258
1998	15,0	2,7	15
1999	10,8	2,3	6
2000	8,1	2,0	1
2001	6,7	1,8	0
2002	13	2,8	12
2003	10,9	2,6	2

Table 10. Radiation dose statistics for nuclear power workers over the last years.

Releases to the environment

SSI has issued regulations on the limitation of releases of radioactive substances from nuclear installations to the environment. The regulations limit the calculated effective dose to representative individuals in the critical group. There are no formal limitations of releases of particular radionuclides. However, all liquid and atmospheric releases of radionuclides shall be measured. The dose constraint is 0.1 mSv per year and site and is independent of the number of release points at the site. The calculation of doses includes six different age groups, and the dose limit is applied to the age group that is receiving the highest dose during the year. Figure 8 shows the radiation doses for the year 2002 for nuclear sites in Sweden.

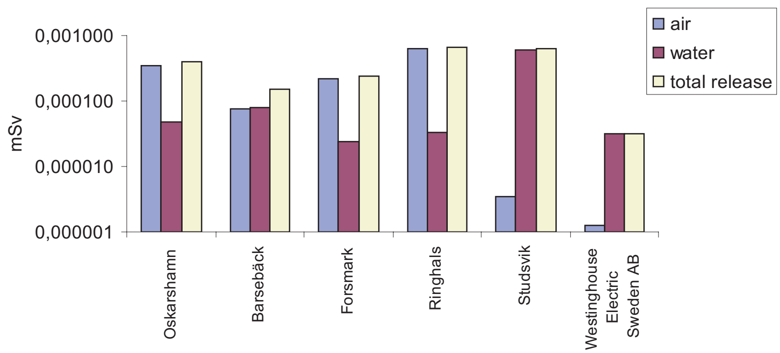

Figure 8. Radiation doses (in mSv) to representative individuals in the critical group from releases in the 2002. (The doses can represent different age groups)

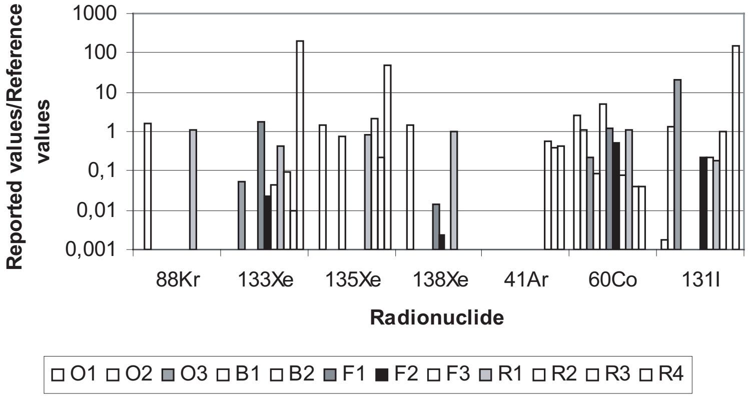

Figure 9. Reported values/Reference values for emissions to air for 2003. (R=Ringhals, O=Oskarshamn, B=Barsebäck and F=Forsmark)

The new concepts reference values and target values have been defined for nuclear power reactors as one measure of BAT. These values are defined by the licensees. The reference value refers to the release rate that is representative for optimum use and full functioning of the delay systems. The target value is defined as the level to which radioactive releases from nuclear power reactors can be reduced during a certain given period of time. Reference and target values have been determined for each nuclear power reactor in Sweden. For various reasons the actual releases will vary between years. A reference value can be exceeded for a particular year but the average value over a number of years should coincide with the reference value. Each year, the reactor licensees shall report to SSI what measures have been taken, or are planned to be taken, to limit radioactive releases with the aim of achieving the target values. The first report has been submitted to the SSI in 2003. Figure Y shows the reported values relative to the reference values for emissions to air for 2003. In particular, the higher values for R4 (>1) is due to a fuel leakage.

15.5 Regulatory control

Regarding inspections performed by SSI, see section 7.4.

15.6 Conclusion

The Swedish Party complies with the obligations of Article 15.

16. Article 16: EMERGENCY PREPAREDNESS

1. *Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installations, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.*
2. *Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the states in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.*
3. *Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.*

16.1 Regulatory requirements

Requirements on on-site emergency activities and plans for the nuclear facilities are included in several legally binding documents:

- The Act (2003:778) on protection against accidents with serious potential consequences for human health and the environment
- The Ordinance (2003:789) on protection against accidents with serious potential consequences for human health and the environment
- The general safety regulations of SKI (SKIFS 1998:1, updated as 2004:1)

The new Act on protection against accidents, which replaces an older similar act, requires preventive measures and emergency preparedness to be arranged by the owner or operator of a facility with dangerous activities. The act further defines the responsibilities for the individual, the local communities and the state in cases of serious accidents, among those radiological accidents.

The Ordinance is more specific about reporting obligations, information of the public, the responsibility of the county authority for planning and implementation of public protective measures, contents of the off-site emergency plan, competence requirements on rescue managers and inner emergency planning and monitoring zones around the major nuclear facilities.

SKI regulations were described in the second national report. In the current revision of the regulations it has been added that the licensee in an emergency situation also shall assess the risk for and the source term of possible radiological releases and report this to the responsible authorities. For this the necessary tools and instructions should be developed. It is also stated more clearly that necessary actions shall be taken promptly at the site, in cases of emergencies, to initiate classification of the event, alarming of the emergency preparedness organisation, assessing the release risk, bringing the plant back to a safe state and to inform the responsible authorities. It is not acceptable if the organisational arrangements delay the initiation of these activities. It is also more emphasised in the revised regulations that emergency planning should include all design basis events, as well as possible beyond design basis events, including severe accidents, and combination of events, such as fire or sabotage in combination with a radiological accident.

SSI is currently also developing regulations on emergency planning and preparedness from the radiation protection point of view. These planned requirements are mainly based on the current IAEA Safety Standards GS-R-2. The regulations are planned to be in force July 1 2005 and include till following preliminary headings:

- Emergency planning
- Alarming
- Assembly places
- Staff arriving to a facility in an emergency situation
- Iodine profylax
- Evacuation
- Training and exercises
- Contacts with SSI
- Emergency facilities
- Emergency ventilation
- Meterological data

On some points the planned SSI regulations overlap SKI regulations. Discussions have not yet been finalised.

16.2 Measures taken on-site and off-site

The measures taken on-site and off-site in cases of a nuclear emergency in Sweden have been extensively described in the first national report and updated in the second. No major changes have been implemented in these arrangements since the last report to the Convention.

There are still two national alarm levels for the nuclear power plants emergencies: increased preparedness and emergency alarm. Implementation of one more, lower level, is presently discussed in order be able to mobilise the off-site emergency preparedness organisation faster.

Two of the nuclear power sites have installed “rapid-reach” computerised systems for alarming the on-site organisations. These systems automatically dial predetermined numbers.

The emergency staff of each nuclear power plant is now included in the general systems used at the plants for staffing, competence analysis, training and annual competence assessment.

Several improvements have been done during the latest years of the emergency facilities at the nuclear power plants. To improve the tools for external information between all responsible parties involved in a nuclear accident, a new information system has been introduced by SSI. The system aims at exchanging information and decisions taken in the event of an emergency situation. It is a web-based PC-system and will be used mainly by the safety authorities and the regional county administrations in the first stage. The system has been used in a few exercises and is still under evaluation.

In order to make the first information transfer faster and more accurate between the affected plant and the off-site authorities, a standard format has been developed. This format is now in regular use at incidents and exercises.

With regard to information to the public in emergency situations, development work is also going on with the objective to provide faster and more adequate information. As a basis for this work, a National Communication Plan has been developed.

In 2002 a new authority was formed in Sweden; The Swedish Emergency Management Agency, SEMA. The task of the new authority is to co-ordinate national work with preparedness for severe emergencies. This is done by implementing a specific planning process for emergency management. Six co-ordination areas are formed in which a number of authorities are jointly responsible for planning and co-ordinating security and emergency measures. SKI and SSI are taking part in the planning process. Strengthening of the emergency preparedness in the society will also strengthen the emergency preparedness for nuclear accidents, for instance in the field of monitoring and measuring.

16.3 Exercises

As mentioned in the first and second reports to the Convention, every year a ”total” exercise is performed in Sweden at one of the four nuclear power sites to check the plans and the capability of the on-site and off-site organisations. These exercises are planned by the respective county authority and they are evaluated by the Rescue Services Agency. Between 15 to 30 organisations usually participate in these exercises. SKI and SSI participate in the planning as well as in the evaluation. The regulatory bodies are of course also exercised. During the last two years, exercise scenarios have included physical protection events, such as sabotage, armed intrusion, taking of hostages etc., in order to exercise co-ordination between the special police forces and other actors. The emergency planning has been reinforced as a result of these exercises.

In addition to the mentioned total exercises, a number of more limited on-site functional exercises are conducted at all the Swedish nuclear power plants every year. Specific plans exist for these exercises. Exercised functions are for instance accident management, communication within the emergency preparedness organisation, environmental monitoring and sampling, assessment of core damage and source terms and assessment of total environmental consequences of a scenario. The rescue forces are also exercised regularly, as well as first aid, emergency maintenance etc. One or more off-site organisations normally participate in these exercises. SKI and SSI have since 2002 participated in at least four such exercises per year which, is a good opportunity to exercise the SKI emergency staff.

An observation made by the special investigator appointed by the Government (se section 6.4) was that exercises in Sweden are well evaluated and results well documented. However, corrective measures seem not to be taken to the necessary extent. Problems identified in exercises have a tendency to reappear. The special investigator suggested to the Government that the Rescue Services Agency has to report back every year to the Government on measures taken as a result of experience gained from exercises. The Government has not yet decided on this issue.

16.4 Measures taken to inform neighbouring States

As mentioned in earlier reports, Sweden has ratified the International Convention on Early Notification and the Convention on Assistance in the Case of a Nuclear Accident. An official national point of contact has been established, available 24h a day

In addition Sweden has bilateral agreements with Denmark, Norway, Finland, Germany and Russia regarding early notification and exchange of information in the event of an incident or accident at a Swedish nuclear power plant or abroad. An agreement on authority level also exists with Lithuania. Regarding the requirements from the European Union concerning the information exchange, the ECURIE information system is now implemented and in use in Sweden.

Between the Nordic authorities, involved in the field of radiological emergency planning, there exists an agreement to exchange data on a routine basis from the automatic gamma monitoring stations in the respective countries. SKI also has a special agreement with the Danish regulatory authority to provide information about safety analyses and other safety relevant information concerning the Barsebäck plant.

16.5 New developments in Emergency Preparedness

As mentioned in the second national report, a user-friendly tool for assessment and prognosticating of radioactive release (HAMPUS) is in use at Barsebäck. In order to find a method that could be used in all Swedish plants, SKI joined the EU FP5 ASTRID project in 2001 (”Development of a methodology and of a computer tool for source term estimation in case of nuclear emergency in a European light water reactor”). The objective of this project is to develop a tool that would take advantage of the time available before any release occurs, thus giving more time for the rescue manager to decide on adequate protective measures.

In order to make ASTRID work for all types of reactors in Sweden, extensive work to adapt it to each plant will be necessary. The utilities have been hesitant to allocate resources to ASTRID and its local implementation at an early stage of the project. Apart from this, the computer tool at present requires specialist competence from the persons using it, something that was not anticipated by SKI when joining the project.

The county authorities, in the four nuclear power counties, have developed their co-operation by now using standardised terminology, technical aids, communication systems etc. They are now training and exercising together, with the ambition to be able to reinforce each other in cases of a major emergency in one of the counties. A formal contract has been signed for staff serving at another county authority in such a case.

SKI has further developed its emergency organisation and work procedures during the last three years, in order to be more efficient and faster in its assessment and advice to the county rescue manager. A new flexible alarm level has been introduced for events that will not require mobilisation of all the SKI emergency staff. Physical protection events have been included in the emergency planning. Training and exercises have been intensified.

16.6 Regulatory control

Since a couple of years, at least one plant visit is done by SKI each year of each major nuclear facility in order to be informed about current developments of the emergency preparedness, and to follow up on earlier remarks. SKI now has two dedicated officers for the emergency preparedness, one mainly working with the internal SKI organisation and one mainly with the nuclear facilities and co-ordination with other off-site authorities.

During 2003, the emergency preparedness was inspected at Oskarshamn and Forsmark. Two further inspections of other facilities are planned during 2004. In general SKI is satisfied with the planning status and how the licensees act during their exercises. There is, however, room for some improvement and fine-tuning of procedures.

During the last year SKI and SSI have assessed Swedish practices against the new IAEA Safety Requirements: Preparedness and Response for a Nuclear or Radiological Emergency, issued 2002. On the mentioned points below it was found that Swedish off-site measures differ somewhat, with regard to the detailed solutions, in comparison with the IAEA recommendations:

- One national co-ordinating authority
- Classification of nuclear and radiological threats
- Analysis of threat scenarios
- Emergency zones and preplanned activities
- National alarm levels

The report of this assessment will be sent to relevant authorities for comments. SSI is responsible for the continued discussion about actions to take as a result of these comments.

16.7 Conclusion

The Swedish Party complies with the obligations of Article 16.

17 Article 17: SITING

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

(i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

(ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

(iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

(iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

17.1 Regulatory requirements

According to the Act on Nuclear Activities § 6, no new nuclear power plants are allowed to be sited in Sweden. Therefore, only the subparagraph (iii) of the obligation is applicable to the Swedish situation.

Requirement on evaluation of site related factors exist in the general safety regulations SKIFS 1998:1, updated as 2004:1, in connection with requirements on the defence-in-depth and general requirements on design and safety analysis. There is also a requirement that all relevant site aspects, examples are given, shall be described in the SAR of the facility.

As described in section 18.1, SKI is currently developing new regulations on Design and Construction of Nuclear Power Reactors (SKIFS 2004:2). These regulations are more specific about natural phenomena and external events.

In § 14 of the new regulations it is stated that the reactor shall be able to withstand natural phenomena and other events originating outside or inside the facility, and with a potential to cause a radiological accident. For all such events there shall be established dimensioning values for the design. Natural phenomena and events with such a fast development, that protective measures cannot be taken when they occur, shall be regarded as initiating events. For each natural phenomena there shall be an established guideline for those situations where the dimensioning values for the design risk to be overrun.

In the general recommendations to these requirements, examples are given on what phenomena to consider: different extreme weather conditions for Sweden, seismic events and events such as external and internal fire, explosion and flooding and airplane crash.

As a result of these regulations the licensees will have to revisit the site impact analyses of their designs and make an updated assessment of the dimensioning values.

17.2 Measures taken by the licence holders and SKI

In the first report to the convention it was described to what extent external events were considered in the design of the nuclear power plants. In general such events were considered to a very limited extent for the oldest reactors. Only the two latest units; Forsmark 3 and Oskarshamn 3 were fully qualified for seismic events in their original designs. During the years, some back fitting has been made on the basis of limited analysis of external events, including seismic. In the recent major modernisation of the oldest reactor Oskarshamn 1 external events have been fully considered and the safety functions have been qualified for seismic events, fire and flooding. Further measures will be taken for the other older reactors as a result of the new regulations mentioned in section 17.1.

As a result of the events in USA September 11 2001, all Swedish reactors have been assessed against deliberate airplane crash. An open version of the SKI review report is published on the SKI homepage, www.ski.se. SKI concludes that consequences of a deliberate airplane crash are difficult to assess, depending on many factors.

A crash of a commercial airplane belonging to normal types in the airspace near to the sites could be managed without any radioactive releases. If a crash of the largest plane fully loaded with fuel is postulated, it cannot be excluded that damages will include radioactive releases. Especially the consequences of consequential fires are difficult to assess. Also in these cases however, the passive filtered venting systems will provide a good protection. SKI has chosen to publish an open version of this report, without giving any details, in order to serve the public interest in this issue.

In 2003 SKI presented a report – ”Guidance for External Events Analysis” – that aims at creating a common framework for analysis of external events as part of a nuclear power plant probabilistic safety assessment. The report was developed under a contract with the Nordic PSA Group (NPSAG), which has members from all Swedish and Finnish plants as well as SKI. It will make it possible for the utilities to perform these analyses in a cost-efficient way, while still assuring the quality of the analyses. The plants have further developed the described basic methodology. Plant specific PSA, based on the deterministic analysis and the site descriptions in the safety reports are ongoing, or planned for the near future (see also section 14.2).

17.3 Conclusion

The Swedish Party complies with the obligations of Article 17 as applicable.

18 Article 18: DESIGN AND CONSTRUCTION

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

(ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

(iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

18.1 Regulatory requirements

Basic requirements on design and construction of nuclear facilities are included in the general safety regulations SKIFS 1998:1, updated as SKIFS 2004:1. The second national report includes an extensive description of these regulations. In short there are requirements on:

- Basic design in order to implement multiple barriers against releases and defence in depth
- Withstanding of failures and events that can affect the barriers and the safety functions of the defence in depth
- Design for reliable and stable operations
- Design for making maintenance, inspection and testing possible
- Design for making safe decommissioning as easy as possible
- Proven or otherwise qualified and verified design
- Design adapted to human abilities to monitor and handle the plant in all operational states and accident conditions
- Design of structures, systems and components according to graded requirements with regard to function and importance for plant safety

During the last years SKI has further developed and specified these general requirements for application specifically on nuclear power reactors. For this purpose new supplementary regulations have been proposed: Design and Construction of Nuclear Power Reactors (SKIFS 2004:2). These regulations are now (May 2004) in the final stage and are being prepared for external review by a number of stakeholders, as required in Sweden. The regulations are planned to be in force from January 1 2005. There are no immediate safety reasons behind SKI's decision to issue these supplementary regulations.

As mentioned in the second national report, SKI several years ago planned to issue guidelines for modernisation and safety upgrading of the Swedish reactors for the rest of the operating time. SKI also had to issue licensing conditions for the extensive upgrading of Oskarshamn 1 1995-2002. During the last years, extensive modernisation programmes have been planned also for the other older reactors. Therefore SKI found a reason to issue general regulations, instead of guidelines only, on design and construction valid for the foreseeable future.

The basis for the new regulations is domestic and international operating experience, recent years safety analyses, results from R&D-projects, recent IAEA Safety Standards and the recent development of applicable industrial standards.

On some issues the new regulations will mean more stringent requirements. On other issues, the regulations will document requirements that are already implemented through licensing conditions or regulatory decisions. In the latter cases the requirements will gain, through a general format, more transparency and will be possible to communicate as a whole to different stakeholders.

The requirements are grouped under the following headlines

- General design principles for the defence in depth
- Withstanding of failures and other internal and external events
- Environmental qualification and impact on other plant systems
- Requirements on the main control room and emergency control post
- Safety classification
- Event classification
- Requirements on the design and operation of the reactor core

There are requirements on

- The basic safety functions up to and including design basis accidents, with regard to
  - redundancy, diversification, physical and functional separation
  - automatic initiation of reactor protection functions
  - fail safe conditions
  - relations between systems for operation and safety classified systems
  - consequences of global and local dynamic effects of pipe breaks
  - withstanding of internal and external events
  - specific rules on fire analysis
  - environmental qualification and environmental impact of equipment on safety functions
  - control and monitoring from the main control room
  - control and monitoring from the emergency control post
  - design and operation of the reactor core

- Design basis extension for dealing with beyond design basis events, including severe accidents, with regard to
  - design of the containment and release mitigating features
  - instrumentation
  - safe final state including cooling of the core/core melt in the long term
  - control and monitoring from the main control room and emergency control post

Since the present 11 nuclear power reactors in Sweden have rather different prerequisites to comply with general regulations on design and construction, a consequence assessment have been made specific for each reactor. The regulations are formulated to allow different solutions, which can be shown to meet the intentions in a reasonable way. According to specific implementation rules, the licensees will be given time to implement the necessary back fitting measures. The first step is submittal to SKI within a year, after issuing of the regulations, of a more detailed specification of the necessary measures and a plan for implementation.

18.2 Measures taken by the licence holders

The previous national reports have included extensive descriptions about implementation in Sweden of the required design principles, both in the original designs and as back fitting over the years. The principle used by the Swedish licensees has been to upgrade the plants successively by a number of plant modifications every year and larger efforts in connection with identified generic problems. One such example was the so called strainer event in Barsebäck 2 1992, where it was evident that the emergency core cooling systems, of the BWRs with external main circulation pumps, did not work as assumed in the safety reports. This event triggered large modifications of most Swedish reactors and also major projects to revise and update the safety reports (se section 6.2).

Since about 1995 the licensees have planned major modernisation of the older reactors in order to make the reactor fleet fit for 40 more years of operation. Oskarshamn 1 started this development. The introduction of deregulation of the electricity market in 1996 suddenly changed the conditions for these long-term investments. Some planned investment programmes were halted and other divided into minor parts. Now the reactor owner companies have adapted to the market conditions and decisions have been taken or will soon be taken on new investments. Section 6.3 provides an overview of the current measures with regard to the investment programmes. In addition to what has been earlier planned, there are now plans for power level uprating of several reactors and investments as a result of the new SKI regulations on Design and Construction (SKIFS 2004:2).

The licensees have made reactor specific assessments on reasonable consequences for each reactor due to SKI:s new regulations. In some cases the consequences will be rather costly. However, several of the measures have already been identified by the licensees and are already included in their investment plans. Therefore in some cases it is difficult to specify the consequence of SKI:s requirements only. Below follows a listing of the major back fitting measures that will be further analysed for the mentioned reactors (within brackets) in order to comply with the regulations. The licensees have pointed out to SKI that it is important that a wide enough timeframe is given for implementation. There are many things to be done in several plants. Also taking into account the new reactor project in Finland, vendor resources will be limited.

- Physical and functional separation
  - Reinforced passive fire protection measures mainly by cable separation and re-routing combined with additional sprinkler systems (B2, O2, F1-2, R1-4)
  - Further separation within the emergency power systems (O2, R1)
  - Separation within the 110 and 220 V systems (F1-2)
  - Separation within the residual heat removal system (R1)
  - Separation within the cooling systems building (B2)
  - Separation within the reactor protection system inside containment (R2)
  - Division of parts of the cooling-chains from the sea into four trains (F1-2)
  - Increase of pressure in the hydraulic scram system (F3, O3)
  - Separation within component cooling and auxiliary feed-water systems (R2)
  - Investigation of additional auxiliary feed-water line (R2-4)

- Diversification
  - Change to two phase flow relief valves (B2, O2)
  - Verification of the relief valves for two phase flow (F3,O3)
  - Modification of the residual heat removal system layout and safety tasks (B2, O2-3)
  - New digital reactor protection system and control room modernisation (B2, O2, R1-2)
  - Investigation of automation of the boron system for reactor shut down (all BWRs)
  - External water supply for emergency core cooling (F3, O3)
  - Additional transmitter for the reactor protection system (R2-4)
  - Diversified measurement of the reactor pressure vessel level (F1-3)

- Accident management
  - New emergency control post (B2, O2, F1-2)
  - Upgrading of the emergency control post (R2-4)
  - Passive hydrogen recombiners (R2-4)
  - Strategy for long term cooling of a severely damaged core (all reactors)
  - Additional assessment of events and phenomena of importance for the containment integrity in case of a severe accident (all reactors)

- Withstanding of local dynamic effects from pipe breaks
  - Protection of containment penetrations of steam and feed-water lines (O2)
  - Supports of several containment isolation valves (F1-2)
  - Measures for reinforced protection (R2-4)

- Planned preventive maintanence during operation
  - Increased capacity of the sea-water cooling-chain for reactor shut down (O3)

- External events
  - Additional assessment and updating of dimensioning values, supplementation of procedures, guidelines and varied design measures (all reactors), see also measures for physical separation above

- Operation of the reactor core
  - Detection of, and automatic protective measures against local core instability (F1-3, O1-3)

- Environmental qualification and surveillance
  - Measures to a varied extent for all reactors

18.3 Regulatory control

As mentioned above, the licensees will be given one year to further specify the technical measures to be taken in response to the new regulations. This specification will be inserted in the safety programmes of each reactor together with other measures (se section 6.3). SKI will follow up on the implementation status at control points specified in time. Final time points for each measure will be decided according to reactor specific plans to be decided later. All major measures are expected to be implemented within an 8-10 year period.

For assessing each technical measure before implementation, SKI will use the notification procedure described in section 14.3.

18.4 Conclusions

The Swedish Party complies with the obligations of Article 18.

19 Article 19: OPERATION

Each Contracting Party shall take the appropriate steps to ensure that:

(i) The initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

(ii) Operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

(iii) Operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

(iv) Procedures are established for responding to anticipated operational occurrences and to accidents;

(v) Necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

(vi) Incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

(vii) Programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organisations and regulatory bodies;

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

19.1 Regulatory requirements

The second report to the Convention contains a comprehensive description of all requirements related to the obligations of article 19. It was concluded that there are requirements in place covering all the obligations. Very few changes have been made in these requirements in the current revision of the general safety regulations of SKI, SKIFS 2004:1. These changes deal with the following:

Operational limits and conditions

It has been added that the Technical specifications for a reactor shall include all limits necessary for ensuring the design limits of the fuel cladding, primary system and the containment. It has also been added that non safety classified equipment, shown to be important for the defence in depth, shall be assigned requirements on availability in the Technical specifications. This is to ensure that all structures, systems and components that are planned to be used for dealing with specific events, are also available when needed.

Approved procedures

It has been added that symptom based procedures shall be in place for a nuclear power reactor, in order to re-establish or compensate for lost safety functions in order to avoid core damage. Such procedures exist at all the Swedish nuclear power plants, as a consequence of a governmental decision 1986, but were not mentioned in previous SKI regulations.

It has further been added that there shall be documented guidelines to control and mitigate the consequences of a severe accident. These guidelines should be developed to the extent possible and reasonable with regard to the need for protection of the public and the environment. The guidelines should be well coordinated with the emergency procedures. Guidelines exist at all nuclear power plants, but there is room for improvement of this concept.

Incident reporting

The revised regulations allow reporting in a collective report of some minor events, without specific safety significance, occurring when the reactor is in the shut down mode.

19.2 Measures taken by the licence holders

The two previous reports to the Convention include descriptions of actions taken by the licensees to comply with the requirements related to article 19. There have been few changes in this during the last three years. Ongoing developments deal with the following.

Operational limits and conditions

The technical specifications document (in Sweden referred to as STF) is being integrated into the plants management systems.

The STF of the Westinghouse PWRs in Ringhals have been updated in a specific project according to the MERITS concept (Methodically Engineered Restructured and Improved Technical Specifications) documented in NUREG 1431 rev 1 and following experience within the Westinghouse Owners Group, documented in NUREG-1431 rev. 2.

Incident reporting

Modifications are being discussed in the reporting forms and projects are going on to find a better classification of different events.

Operating experience analysis and feedback

The Swedish utilities participate in various owners groups: Westinghouse Owners Group (WOG), BWR Owners Group (BWROG), Framatom Owners Group (FROG), Nordic Owners Group (NOG). Some plants also have direct cooperation with other plants (i.e. Forsmark with the Finnish plant TVO and the German plant Gundremmingen).

The bilateral exchange between plants often gives valuable experience and insights on important safety issues. A specific example is the Forsmark 3/Gundremmingen co-operation. Some years ago Grundremmingen experienced an event that resulted in rapid heat-up of the reactor pressure vessel. This event was similar to the one that occurred in Oskarshamn 3 in 2003 (see section 6.1). Forsmark made changes to their procedures as a result of the Grundremmingen event, and would consequently have been better prepared to deal with such an event than showed to be the case at Oskarshamn 3.

Participation in owners groups is valuable as well, although it is a more demanding task to screen out the operating experience relevant to a specific plant design. The Nordic Owners Group work has led to an effective coordination of R&D efforts. Many of the projects initiated by NOG would have been too costly for a single plant to run.

19.3 Regulatory control

The SKI review of the incident reporting from the licensees follows the same procedure as reported three years ago. All reports from the licensees are screened as a routine every week by a group of four inspectors, making a first assessment as to whether these reports need further regulatory attention. A larger group of inspectors and experts meet every two weeks, to confirm the assessments made by the preparatory group.

The annual number of event reports (LER) is fluctuating somewhat between years in the range of about 20-30 per reactor unit. The long-term trend is decreasing numbers. In about 10 cases per year, SKI makes a further in depth investigation and in about five cases SKI requires further measures to be taken by the licensee, as a result of the investigation.

In cases of more serious incidents, SKI has a procedure for making an early investigation on-site. This procedure was applied in the Oskarshamn 3 case of rapid heat up of the reactor pressure vessel, mentioned in section 6.1. The rapid investigation procedure has been used in very few cases over the years. Normally the licensee reporting provides the necessary information, together with SKI verifications on-site, for making the needed regulatory decisions. Reporting within an hour is required for the most serious events.

19.4 Conclusion

The Swedish Party complies with the obligations of Article 19.

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