SWEDEN´S SECOND NATIONAL REPORT UNDER THE

Convention on Nuclear Safety

Swedish implementation of the obligations of the Convention

Ds 2001:41

CONTENTS

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

During the period before the review meeting, Sweden received in total 42 questions on the report from 11 countries, which were relatively few questions to a country with such a large nuclear power programme. The questions addressed many different areas and no special weaknesses were identified. They were mostly requests for clarifications and minor additions.

During the discussion at the review meeting it was agreed that Sweden seems to comply well with the obligations of the Convention, although certain issues should receive special attention. It was mentioned, for instance, that the decision to start the phase out of nuclear power may affect the interest of young engineers to join the nuclear sector. The future supply of competent staff may need to be safeguarded by special measures. As a consequence of electricity market deregulation in Sweden, methods may need to be developed to prioritise safety more clearly. Further, it was mentioned that the radioactive releases to the environment have been low, but positive examples shown by other countries around the Baltic Sea indicate that there is room for reduction of radioactive releases to water from Swedish reactors.

The openness shown by Sweden in exposing its nuclear programme to international review was commended. The emphasis of organisational issues in the safety work was noted with great interest, as well as the industrial programme to update the SARs, the measures put in place for coping with severe accidents, the new programme for issuing of SKI regulations and the SKI work to implement a new quality management system.

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

- measures to upgrade the older reactors and how these comply with the safety regulations,
- measures within the industry and the regulatory bodies to improve the safety culture,
- monitoring of the effects, if any, on safety as a consequence of deregulation of the electricity market,
- experience gained from the new SKI safety regulations, especially with regard to the higher requirements placed on the licensees own control over safety.

As was the case with the first report, the present report has been produced by a four persons working group with one representative each from the Nuclear Power Inspectorate, the Radiation Protection Institute,

Vattenfall AB and Sydkraft AB. The Nuclear Power Inspectorate was assigned the task to co-ordinate the work. Before submission to the Government the report was sent for comments to the nuclear industry, the relevant authorities and some interest organisations. It was also presented in the SKI Advisory Committee on Nuclear Safety and in the boards of SKI and SSI.

The first report was a rather comprehensive description of the Swedish nuclear power programme in all aspects relevant for the obligations under the Convention. The present report has the same structure but is only focusing on the development after July 1998. In order for the report to stand alone references are made to the first report to the Convention.

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
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
I&C Instrumentation and Control
IGSCC Inter Granular Stress Corrosion Cracking
INES The IAEA/NEA International Nuclear Event Scale
INPO Institute of Nuclear Power Operations
KSU KärnkraftSäkerhet och Utbildning AB (the Swedish Nuclear Training and Safety Center)
KTH Kungliga Tekniska Högskolan (Royal Institute of Technology)
LER Licensee Event Report
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

R&D	Research and Development
SAR	Safety Analysis Report
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
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 are needed. Improvement measures in those areas should be implemented when needed and be followed up in the National Reports to subsequent Review Meetings.

Since the first report to the Convention was issued, three major events have been experienced in the Swedish nuclear programme:

- After several decades of political discussion, the phase out of nuclear power started by the closing of one unit (Barsebäck 1) of a twin unit plant on 30 November 1999.

- The full effects of deregulation of the electricity market have been experienced. Together with increasing taxes on nuclear power, this has strongly affected the production economy of the nuclear industry resulting in efforts to reduce production costs and leaving less room for investments.

- The new general safety regulations of SKI (SKIFS 1998:1) came into force 1 July 1999, resulting in a more structured approach to inspection and safety assessment.

These changes have created new challenges for the safety work of the licensees as well as for the regulatory bodies during the last three years. However, the generally positive impression reported to the first review meeting under the Convention still stands. Therefore, Sweden would like to point out the following as strong features in its national nuclear practice:

- The responsibility for safety is very well defined in the Swedish legal framework. In order not to dilute the responsibility of the licence holders, the Swedish regulations are designed to define what is required to be achieved, not the detailed means to achieve it. Within the framework given by the regulations, the licensees have to define their own solutions, and demonstrate the safety level achieved to the regulatory bodies.

- There is an open, and on the whole, constructive relationship between the regulatory bodies and the licensees. Examples of this are the conduct of joint research projects and the continued dialogue to

define reasonable safety objectives for the Swedish nuclear power plants for the remaining operating time, where the roles of both sides are fully respected.

- The majority owner companies are well established with good corporate financial records. Despite financial strain created by deregulation of the electricity market and heavy international investments, they have so far demonstrated a continuous commitment to maintain a high level of safety and continue to make safety investments in their nuclear power plants.

- Notwithstanding the increased competition, the licensees continue to co-operate in solving important issues for safety. This includes experience feed-back analysis, a component reliability database, qualification of companies for non destructive testing, co-ordination of outages, nuclear waste management, auditing of vendors, and, most recently, a joint group defining the requirements and objectives for future safety improvements.

- The nuclear infrastructure in Sweden is, on the whole, well developed with adequate support to the licensees and the regulatory bodies. Major international nuclear companies are established in the Swedish market. The regulators in Sweden have also been 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:

- Further changes in ownership and in the structure of the operating organisations, such as downsizing, outsourcing and merging, need to be followed closely, by the licensees as well as by the regulatory bodies, and methods need to be further developed to assess the safety consequences of such changes.

- The ongoing dialogue between the licensees and the regulator (SKI) regarding development of safety in existing reactors needs to be concluded, in order to define reasonable requirements for back-fitting during the remaining operating time. This includes a common view on the use of risk-informed justifications and on the relation of the Swedish safety requirements to those of other countries, especially within the EU.

- The general concern expressed in the first report to the Convention about the shortage of qualified, university trained engineers and researchers in specific nuclear fields, still remains in the longer perspective, although there are decisions or advanced plans to maintain a number of professorships in nuclear subjects. A plan is also under discussion to ensure financing of nuclear education and research at several universities for at least a three year period. The need for specialist nuclear competence during the remaining operating life-time of the reactors and for decommissioning is currently being

investigated. Taking into account all these efforts, an action plan should be developed to ensure the necessary long-term nuclear competence in Sweden.

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

At the first review meeting in April 1999, Sweden accepted to report on the following issues in particular, in its next report:

1. measures to upgrade the older reactors and how these comply with the safety regulations,

2. measures within the industry and the regulatory bodies to improve the safety culture,

3. monitoring of the effects, if any, on safety as a consequence of deregulation of the electricity market,

4. experience gained from the new SKI safety regulations, especially with regard to the higher requirements placed on the licensees own control over safety.

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

1. section 6.3

2. section 12.4

3. section 6.4

4. section 8.5

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 150 TWh in year 2000 as compared to 143 TWh in 1998[1]. This is the highest consumption ever in Sweden. The hydropower production was 79 TWh in year 2000 (55 percent of the total) which is a new record. Wind power production was 0.4 TWh (0,3 percent), combined heat and power production using a variety of fuels, including biofuels, contributed to about 9 TWh (6 percent) and nuclear power production was about 55 TWh (39 percent), a reduction with 20 percent from 1999 (70,2 TWh). This reduction had to do with the closure of Barsebäck 1 and output reduction of the nuclear units due to the very good supply of hydropower. In a normal year the production shares of hydropower and nuclear power are about equal. In 2001 the availability of hydropower has decreased considerably compared to year 2000.

2. Technical 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 power plant Ågesta, which was operated from 1964 until 1974, when it was decommissioned. The first commercial nuclear power plant 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).

In the time period since the first national report was issued, the development has been much influenced by political decisions (see next chapter). The most important decisions were the final closure of the Barsebäck 1 plant and extension of the time limit for decommissioning of the remaining units beyond the year 2010, which was previously the target date for nuclear phase-out in Sweden. Another factor strongly influencing the development of Swedish nuclear power industry is the deregulation of the electricity market and the further increase of competition, resulting in a strong pressure to reduce costs.

The perspective of operating the present plants for several decades more has initiated development programmes for defining adequate safety levels to be required for extended operation. Projects with this purpose have been pursued by both the regulatory body (SKI) and by the industry. Views have been exchanged between the parties and it is expected that a back-fitting guideline will be issued by SKI during 2002.

The strong focus on cost reduction has caused the industry to revisit the modernisation programmes under way and in several cases to reduce or postpone such investment in the plants, which are not required

[1] According to the activity report 2000 from the organisation "Swedish Energy". The figure is corrected for the average outside temperature.

for safety reasons. It has also put strong emphasis on the need to predict the future safety requirements as a basis for investment decisions.

3. Political Development of the Nuclear Power Issue

Nuclear power has been a very prominent issue in the political debate in Sweden since the 1970´s. The first report to the Convention includes a description of the major political decisions taken as a background to the current status of the nuclear programme. This description ended with the "Act (1997:1320) on the phase out of nuclear power" approved by Parliament in December 1997. Pursuant to the new act, the Government decided in February 1998 that electricity production at Barsebäck 1 is not allowed after 30 June 1998, because of conversion of the energy system. In March 1998 Sydkraft AB, the owner of Barsebäck NPP, appealed this decision to the supreme administrative court and was in May granted an inhibition of the decision until the legal procedure had been completed. In June 1999 the court announced that the decision by the Government would stand, although Barsebäck 1 was allowed to continue operation until the end of November 1999. After the court´s decision, negotiations started between the Government and Sydkraft AB about reimbursement for the shut down. A final agreement was approved by Parliament in May 2000. As a consequence of the agreement, a new company within Sydkraft has taken over the ownership of the two Barsebäck units and Ringhals AB (the operator of Ringhals NPP) has taken over the operation of Barsebäck 2. Barsebäck 2 will be closed when the conditions stipulated by Parliament in its 1997 phase out decision are met. These conditions include both reductions in the use of electricity and the introduction of new, environmentally acceptable sources of supply. The Government estimates that these conditions should be met at the latest by the end of 2003. It should be noted that the earlier political decision to phase out all nuclear power in Sweden 2010 by the latest, has been revoked as a result of the 1997 energy policy decision on the phase out of nuclear power in Sweden.

4. Nuclear Power Installations in Sweden

At present, in May 2001, there are 11 nuclear power units in operation in Sweden as specified in Table 1. Two units are permanently shut down, namely Ågesta and Barsebäck 1.

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

Table 1. Nuclear power installations in Sweden. Main data.

All the BWRs were designed by ASEA-ATOM (later ABB Atom, now Westinghouse Atom) and all the PWRs except Ågesta by Westinghouse.

Ownership, organisation and staffing

The political decision to close Barsebäck 1 and the internationalisation of the electrical power market has resulted in significant changes in the ownership structure of Swedish nuclear power industry. As mentioned

[2] According to SKI information.
[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 30 November 1999 according to a governmental decision.

in chapter 3, the closure decision was accompanied by an agreement between the Swedish state, Vattenfall AB and Sydkraft AB regarding economic compensation to Sydkraft AB. This compensation is essentially given in the form of co-ownership of the Ringhals NPP, which has been established as a legal unit of its own Ringhals AB. At the same time, the company operating the Barsebäck NPP was taken over by Ringhals AB, forming the Ringhals Group operating both Ringhals and Barsebäck. The formal ownership of the Barsebäck units is still with Sydkraft AB, through its subsidiary company Sydsvenska Värmekraft AB. The new ownership structure is shown in the revised version of Figure 1 below. In this figure, some further changes of the shares held by the different owner companies have been included. These are the result of business deals, which have just been formally completed.

The on-going 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 has acquired large power production assets in Poland and 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 major German utilities, E.ON, has acquired a majority of the shares, and has indicated its intention to increase its share further.

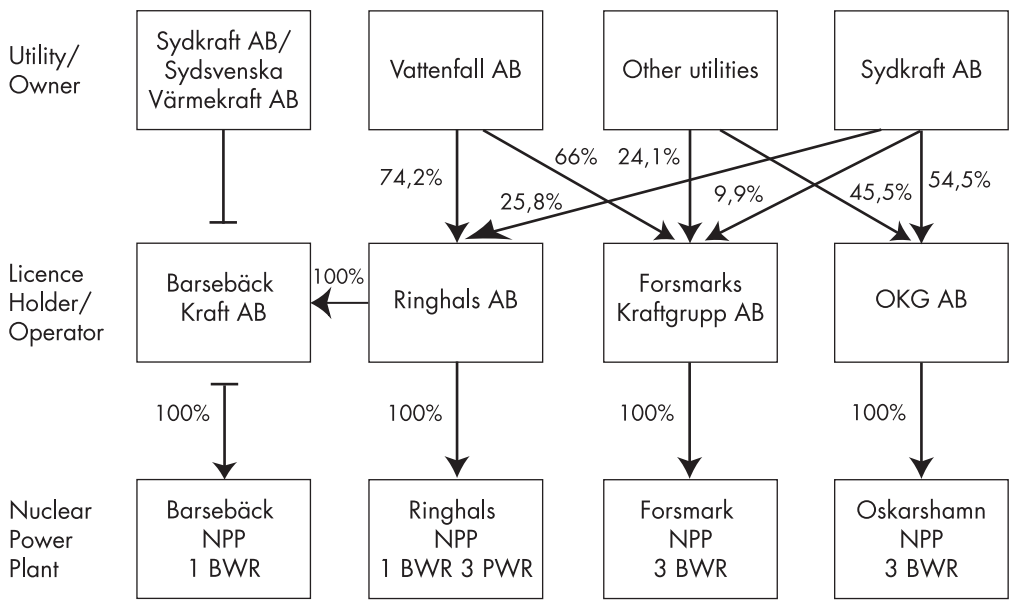

Figure 1. Utility structure and owner relations.

Concerning organisation and staffing, the previous trends of slimming organisations and outsourcing functions outside the basic nuclear competence area have continued, although not comprising personnel in safety related positions. The closure of Barsebäck 1 has so far resulted in moderate staff reductions, which are expected to continue over the next few years. The staff figures for the different sites compared with those in the first report to the Convention are:

Nuclear power plant	Staff 2001	Staff 1998
Barsebäck	360	430
Forsmark, incl. SFR	740	850
Oskarshamn, incl. CLAB	900	1050
Ringhals	1080	1200

Table 2: Staffing of the Swedish NPPs 2001 compared with 1998.

The staff reductions shown in the above table are partly compensated by full-time contractors in out-sourced functions.

Own support organisations

The support organisations for training, experience feed-back and qualification of systems for non-destructive testing were described in the first report to the Convention and few changes have taken place in the interim.

A formal ownership change has been made so that the shares in the supporting organisations KSU, SQC and SVAFO previously held by Vattenfall AB have been taken over by the subsidiaries operating the plants (Ringhals AB and FKA). The co-operation on experience feed-back between the BWR operators in Sweden and Finland has continued under the name of the Nordic Owners Group and with the ERFATOM organisation carrying out the event and trend analyses. The joint membership in the US INPO organisation held by KSU has been terminated.

Other commercial services in the nuclear power field

The supply of services in the nuclear field is being affected by the restructuring of the international nuclear industry. The domestic supplier ABB Atom has been acquired by the Westinghouse Corporation of the

BNFL group and is now operating as a subsidiary of Westinghouse under the name Westinghouse Atom. This and other mergers under way (e.g. Siemens and Framatome) will result in a smaller number of large full-service suppliers competing on the market.

Nuclear waste

The activities of the various organisations dealing with low and intermediate level waste and spent fuel are described in the first report to the Convention. The routine operations in this area have continued along the lines described. The interim storage facility for spent nuclear fuel, CLAB, is currently being expanded from 5000 tonnes to accommodate 8000 tonnes of spent fuel by building new storage pools. The development work for the final disposal of spent fuel has continued according to plan and the process for selecting suitable sites for the final repository is underway.

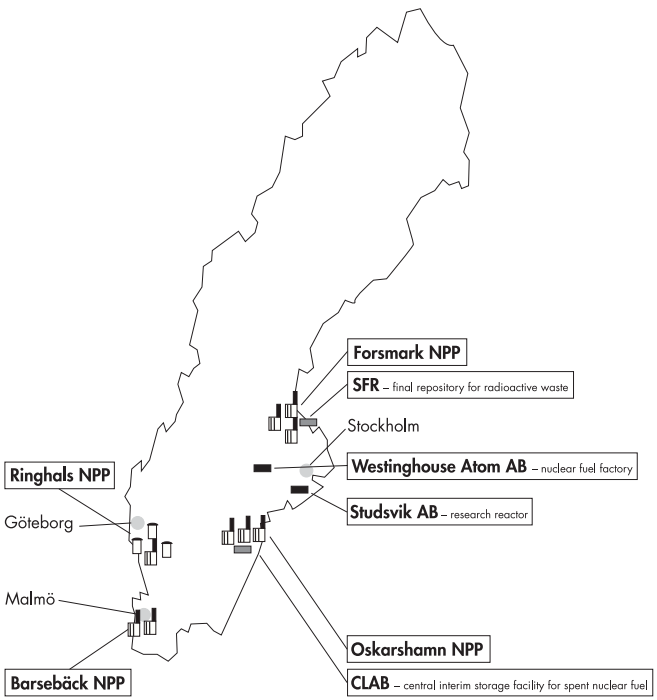

Figure 2. Location of the nuclear facilities in Sweden.

Facilities for nuclear education, research and development

The academic education in nuclear technology in Sweden is mainly concentrated to the Royal Institute of Technology (KTH) in Stockholm 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.

According to current plans, the following academic resources with a specific nuclear technology profile will be maintained in Sweden for higher education and research:

KTH
- Nuclear Reactor Engineering (one professorship)
- Nuclear Power Safety (one professorship financed by SKI)
- Nuclear Chemistry (one professorship)
- Reactor Physics (one professorship)

CTH
- Reactor Physics (one professorship)
- Nuclear Chemistry (one professorship)

Stockholm University
- Human Factors (one professorship financed by SKI)

Mälardalens Högskola (a regional university)
- Human Factors (one 75% associate professorship, financing guaranteed by the nuclear industry for 3 years)

In addition to the professorships, there are 8 lectureships at the above mentioned divisions of KTH and CTH.

5. Swedish Participation in International Activities to Enhance Nuclear Safety

Regulatory bodies

In the first report to the Convention, it was concluded that representatives from Sweden 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 work.

In 1999, Sweden joined the Western European Nuclear Regulators Association (WENRA). This association includes the heads of the regulatory bodies in the EU countries with nuclear power programmes, and in Switzerland. The Association has the following objectives

- to develop a common approach to nuclear safety and regulation, in particular within the European Union,
- to provide the European Union with an independent capability to examine nuclear safety and regulation in applicant countries,
- to evaluate and achieve a common approach to nuclear safety and regulatory issues which arise.

One important piece of work already done by WENRA is an evaluation of the nuclear safety of the seven candidate countries, to the EU, which have active nuclear power programmes. A first report was published in March 1999 and an update was published in October 2000. Another important ongoing project within WENRA is to develop and test a methodology for comparison of safety requirements in the different countries, as a basis for discussions about harmonisation.

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 SKI through the Swedish International Project Nuclear Safety (SIP) in co-operation with the SSI unit for international support International Development Co-operation (SIUS). Since 1991, Sweden has allocated 460 MSEK for international technical assistance within the designated areas. The appropriation for 2001 is 60 MSEK including 10 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.

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.

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 second 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 reasonably 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 The general safety status

In their annual reports to the Government for the years 1998-2000[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 is room for improvement.

During 1998, two events were reported where safety systems were not operable at the restart of the reactors after outage. Since similar events have occurred before, SKI concluded that the measures taken

[5] SKI Reports 99:12, 00:15 and 01:10, SSI Reports 99:09, 00:10, 01:06 (in Swedish only).

so far by the utilities had not been adequate. However, it was observed that new efforts were made and co-operation between the utilities had been initiated to find more effective solutions, including commissioning research efforts. A BWR core instability event also indicated room for improvement in the operating organisation about how to handle such events.

During the 1999 outages relatively extensive intergranular stress corrosion cracking was detected in the supports of the core spray systems in Oskarshamn 2, Barsebäck 1-2 and to some extent in Ringhals 1. This damage also revealed some weaknesses in the materials inspection schemes applied. Further defects were detected during the 2000 outage. More unexpected intergranular stress corrosion cracking was found in Ringhals 4 (a Westinghouse PWR plant) during the annual check of connections between the reactor pressure vessel and the main cooling circuits. SKI has closely followed the work of the utilities to investigate and implement corrective measures to these problems and as a result SKI required further investigations and imposed operating limits on the affected reactors. SKI concluded that further close supervision is necessary, as well as further development of the testing methods in order to characterise the cracks. Another experience was that the utilities should improve their preparedness to handle unexpected defects.

Extensive measures have been taken at some plants to avoid further intergranular stress corrosion problems. For instance, at Forsmark NPP (BWR) some reactor pressure vessel internals and connected piping have been replaced.

As a result of electrical disturbances, two more BWR instability events occurred in 1999. In all the cases, the safety systems functioned as expected and there was no fuel damage. SKI concluded that one cause for this type of event is the core reloading optimisation used in some plants. Knowledge about this and other factors of importance to the stability of the core has in some cases been insufficient. Measures were taken by the utility to improve core management, staff training, and to install new scram conditions and monitoring equipment.

Already in 1998, it was observed by the regulatory bodies that the conditions for the safety work of the utilities were changing, due to deregulation of the electricity market and associated higher competition and lower prices to the producers. At the same time, increasing taxes were imposed in Sweden on nuclear power[6]. As a result, the room for investments decreased significantly and it was observed that the utilities implemented large cost cutting and rationalisation programmes. The regulatory bodies expressed concern that the utilities would cut down safety investments as well as experience feed-back and other co-operation with safety benefits to the industry. However, the management of the utilities assured the regulators that safety is a clear part of their business concept and that safety will be prioritised as prior to deregulation. The regulatory bodies have concluded that they need to pay attention to how the utilities manage these changes, maintaining continued vigilant safety- and radiation protection work. It should be observed that the market price of electricity has recently increased significantly and is expected to fluctuate, depending on the supply of hydropower.

The utilities have generally shown high ambitions to reduce radiation doses. In 1998, the collective dose to staff and contractors was 15 manSv, which is much less than observed earlier in the 1990´s. The doses to the public in the neighbourhood of the plants have been less than 1% of the limit. In 1999, the collective

[6] The tax was 2.7 öre/kWh until 1 July 2000. It was then transferred to fixed tax on installed thermal power. It is now SEK 66 168/MWth and year. A reduction is made if a reactor has been shut down more than 90 successive days.

dose to staff and contractors was further reduced to 10,8 manSv which was the lowest value ever. In 2000, the collective dose was reduced even further. According to SSI this trend is due to good planning, better staff awareness, less extensive maintenance and repair, and gains from dose reduction investments made during the last 5-10 years. In connection with possible effects of market deregulation, SSI has concluded, that despite this very satisfactory development in doses, it is important to pay attention to predictive indicators in order to monitor the future radiation protection performance.

After the governmental decision to close Barsebäck 1, SKI decided to follow the situation closely. The utility started the planning early of several measures in order to maintain safety and the motivation of the staff, and has reported each month to SKI. The final shut down date was 30 November 1999. In summary, SKI has concluded that the utility handled the difficult shut down situation in a competent way. A close surveillance will, however, be kept over the continued operational safety of Barsebäck 2.

No significant events occurred in the Swedish plants in connection with the millenium passage.

6.2 Overview of safety assessments performed

Probabilistic Safety Assessments

After the general safety regulations (SKIFS 1998:1) came into force 1 July 1998, the use of the PSA methodology is seen as an integrated part of the ordinary safety work of the licensees, and not only as a part of the periodic safety reviews every 10 years. In principle, all reactors should have complete level 1 and level 2 studies including all operating modes and all relevant internal and external hazards for the sites. This has not yet been accomplished, therefore SKI has issued specific requirements to the respective licensees regarding completion of the studies. The current situation is summarised in the table below.

Plant	Level 1	Level 2	Fire, Flooding	Low power, Refuelling	Start up- and shut down	External events
Barsebäck 1 and 2	1998	1995	1998	1995	1998	
Forsmark 1 and 2	1995	–	1997 (only fire)	–	–	
	2001	2001	2001	2001	2001	Limited study
Forsmark 3	1995	1995	1995	1995	–	
Oskarshamn 1	1997	1998	1997	1998	–	
Oskarshamn 2	1999	1999	1999	–	–	
Oskarshamn 3	1998	1998	1998	–	–	
Ringhals 1	1992	1996	1997	–	–	
Ringhals 2	1992	1994	1994	1995	–	
Ringhals 3 and 4	1992	–	1997 (only fire)	–	–	

Table 3. Latest PSA versions reported to SKI.

Major work ongoing currently are a new PSA model for Oskarshamn 1, taking into account the comprehensive plant modifications, an update of the level 1 study for Ringhals 1 and a major update of the studies for Ringhals 2-4. Forsmark has just completed a major update of the studies for units 1 and 2.

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 utilities have such safety objectives. SKI requires that the studies are sufficiently detailed, comprehensive and realistic to identify weaknesses in the plant configuration and that they can be used to assess plant modifications, modifications of technical specifications and events.

In 1999, based on PSA results, OKG and BKAB improved the reliability of the electrical supply systems and fire protection in the ”triple units” Barsebäck 1-2 and Oskarshamn 2. Further measures have been taken at Oskarshamn 2 to increase the reliability of the emergency core cooling in the event of fire, and at Barsebäck 2 to connect the electrical systems to the decommissioned unit 1 in order to further improve the reliability (more details are provided later in this chapter).

Design basis reconstitutions

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 of these efforts have been

- to develop a complete modern safety report (SAR) for the units and to verify the basis for the report,
- 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.

Considerable work has been needed, especially for the oldest reactors. It has been necessary to extend the planned time schedules. The result is that Barsebäck 2, Oskarshamn 2 and Ringhals 1 now have updated safety reports. The projects have identified some weak points in the original designs and a number of open issues subjected to further analysis by the operating organisations. The identified weaknesses have not been considered to be serious enough to interfere with the safe operation of the units, however, they have been corrected, or are scheduled for correction in the near future.

Corresponding reassessments have been started for the PWR units at Ringhals. This work has been delayed but is planned to be completed in 2003. For Forsmark 1-2, which already have more modern safety reports, work is ongoing to identify weaknesses in the present reports. This project is in its final phase, but not yet submitted to SKI.

For the most modern plants Oskarshamn 3 and Forsmark 3 the reassessment project is scheduled to be completed in 2003, and the assessment regarding modern requirements in 2005.

SKI regards the safety reports so far submitted as a substantial improvement of the 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, and SKI will make an extended review and assessment on this point.

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, documented and acceptable for the regulator. 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 unit during the 10 year period.

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

Reactor unit	Licensee report completed	SKI review report completed
Oskarshamn 1	1992 (second)	1995
Barsebäck 1 and 2[7]	1995 (second)	1996
Ringhals 2	1994 (second)	1995
Oskarshamn 3	1996 (first)	1997
Forsmark 3	1997 (first)	1998
Ringhals 1	1995 partly 1998 (second)	2000
Oskarshamn 2	2001 pl (second)	
Forsmark 1	2001 pl (second)	
Forsmark 2	2001 pl (second)	
Ringhals 3 and 4	2002 pl (second)	

pl=planned

Table 4. Latest versions of periodic safety reviews.

[7] One common ASAR is allowed for twin units if the conditions for safety are the same.

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.

6.3 Reactor modernisation programmes

In Sweden there are seven design generations of reactors in operation as shown in the first report to the Convention. These designs were made in the sixties and the seventies. The first reactor Oskarshamn 1 was commissioned in 1972 and the last, Oskarshamn 3 and Forsmark 3, in 1985. In the early nineties it was evident to the utilities that the older Swedish reactors in particular needed to be renovated and modernised, in order to comply with current and higher requirements concerning availability and safety. For instance, higher requirements on in-service inspection and testing and a higher maintainability were motives for such efforts. In some cases, equipment needed to be changed because it was old and spare parts or competence were difficult to find. Instrumentation and control systems are examples where old analogue technology is being replaced with modern digital and often programmable equipment. Despite benefits, the new technology at the same time poses new demands on the safety work of the licensees.

In the first report 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. As a result of the new economical conditions after the electricity market deregulation, these plans have been modified to varied extents for the different units.

In the first review meeting under the Convention, Sweden was asked to present in its next report more details on the upgrading of the older reactors and how these comply with the safety regulations. A technical overview over the current situation follows below.

- **Oskarshamn 1**

For the oldest unit, Oskarshamn 1, the extent of the modernisation programme has not been changed in principle as the plans have been fixed for quite a long time. The completion of the original modernisation programme, which will bring the reactor safety of the unit to a safety level that, as far as possible, corresponds to that of modern reactor designs, has also been a condition from SKI for granting a continued operating permit for the unit. Parts of that programme, as it was described in the first report to the Convention, have been completed. As an example the reactor internals, including the core shroud, the shroud head and the steam separators, were replaced during an extended refuelling outage in 1998. However, the time-schedule for the remaining measures has been somewhat delayed, for various reasons, although present plans are that the programme will be completed during an eight month outage starting at the end of 2001.

By then, the following measures will be completed, and the corresponding functions and systems ready for operation:

- 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, and
- A new emergency control building, as well as some modifications to existing buildings.

The modernisation of the safety systems is achieved by a functional group concept consisting of three diversified possibilities for emergency core cooling and residual heat removal. The first group comprises the unique auxiliary condenser and a new independent demineralised water supply line connected to the demineralised water storage tank. The second group comprises the twofold auxiliary feed-water system, the four power-operated relief valves and the two-train containment heat removal system, while the third group consists of the two-train low-pressure emergency core cooling system (100 % each) and the two-train containment heat removal chain. The installations and components of the third group are designed and qualified to withstand seismic loads.

The emergency power supply system will consist of four separated safety trains. Two of them will be powered by two new diesel generator sets, while the remaining two are to be powered by the two re-qualified existing diesel generator sets.

The new I&C system for safety systems and the new reactor protection system are of a fourfold redundant design with total physical and functional separation.

A completely new emergency control building has been erected to house the new systems and components. The following main components are installed in the building.

- Two diesel generators including auxiliary systems and fuel tanks, completely physically separated
- Two secondary cooling water pumps and heat exchangers for safety systems
- Two auxiliary feed-water booster pumps
- A pump for supplying demineralised water to the auxiliary condenser basin
- Switch gears, batteries and busbars for the redundant safety trains

- A physically separated four-train reactor protection system and other I&C equipment

- A redundant ventilation system

The building has been designed to withstand all types of external events, including the seismic loads defined for Oskarshamn 1. Installations and electrical and mechanical equipment in the building have also been designed and qualified to withstand seismic loads.

In the emergency control building an emergency control room is also located in order to provide backup capability for plant control in case the main control room is unavailable. In the emergency control room, it is possible for the operators to monitor and control the reactor process from full power level down to subcritical, cold and depressurised condition, and to maintain the reactor in that condition. The emergency control room is completely separated and independent from the main control room.

The original main control room is completely modernised in areas in which new equipment has been installed, whereas existing control equipment and panels have been maintained, where no changes have been made. A safety desk has been installed and has the same function as a Safety Display Panel. The emergency control room also contains a replica of the safety desk and the control functions that are part of the safety concept as indicated above.

Replacement of the steam turbines is also a part of the modernisation programme, with the objective to increase availability and thermal efficiency. The HP turbine was exchanged recently and the LP turbines will be changed during the up-coming extended outage.

- **Barsebäck 2 and Oskarshamn 2 and 3**

The mutual modernisation programme for the almost identical triplet units Oskarshamn 2 and Barsebäck 1 and 2 has been revised stepwise. This development has been affected by the uncertainty regarding the safety requirements for the future operation of Swedish nuclear reactors (see sections 18.1 and 18.2) and the decommissioning of Barsebäck 1 in 1999. The programme was first divided into a reconditioning and a modernising phase for the remaining two units, and then split into smaller projects for each plant, but with a certain degree of bilateral co-operation. The following are examples of such projects that also underline that priority is given to safety related measures.

One result of the latest PSAs for the triplet units was the identification of a weakness in the auxiliary power supply to the auxiliary feed water system, due to unsatisfactory separation of cables in the event of fire. The resolution of this problem in Oskarshamn 2 was power supply to the auxiliary feed water system from a separate new building containing control and electrical switch-gear equipment. This was implemented in 2000. A similar resolution was intended for Barsebäck 2, but in this case advantage has been taken of the closed-down unit 1, enabling the auxiliary feed water system to be supplied and controlled from the electrical building in Barsebäck 1. An added value to this resolution that will be realised 2001, is that the two sets of diesel-generators in Barsebäck 1 will serve as a back up for the power supply.

The second example deals with the replacement of an extensive part of the piping, penetrations and valves in the primary systems within the reactor containment. The motives are several, including IGSCC-sensitive material, difficulties to reach welds for material inspections, increased demands on isolation valves and improved knowledge through new analyses concerning dynamic loads in certain systems. The measures, which will be preceded by a chemical decontamination in order to reduce the dose rates, will be accomplished in Oskarshamn 2 and Barsebäck 2 during extended refuelling outages in 2002.

According to current plans, the modernisation phase for Oskarshamn 2 will start after 2002 and reach its peak in 2005, when around 250 MSEK will be invested. For the newest unit, Oskarshamn 3, a modernisation will also be implemented which will be less comprehensive, and not start until 2006.

- **Forsmark 1, 2 and 3**

The comprehensive modernisation programme for the Forsmark plant, Program 2000, which was started in 1995, has been completed. During the time period since the previous national report the following major modernisation items have been implemented:

- Replacement of the core shrouds and core grids (F1, F2) and parts of the in-vessel feed-water system (F1, F2, F3)
- Replacement of piping in the primary system to less corrosion sensitive material (F1, F2)
- Improved reactor cooling during shut-down (F1, F2)
- Improved cooling of the reference leg in the reactor vessel level measurement system (F1, F2)
- Comprehensive control system renewal, including a new basic control concept and computers (F1, F2)
- Modernisation of the control rod manoeuvering and TIP (travelling in-core probe) system (F3)
- Upgrading and improvement of fire protection and alarm systems (F1, F2, F3)
- Replacement of the frequency conversion equipment for the reactor coolant pumps (F1, F2, F3)
- Modernisation of the turbine/generator system including both the electrical and control equipment (F1, F2)

For the current and future modernisation of the plant, a strategy and modernisation plan has been adopted (Program P40+). The aim of this programme is to secure plant safety and the technical status for the

next 10 years, and thereby maintain continued public confidence in the safety of Forsmark and retain the option for operation for 40 years or more. The 40+ program contains modernisation items, of which 70% 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 2001 investments for about 360 MSEK have been committed.

In the FKA safety development programme for 2001, a list of prioritised items for safety improvement is defined. Those given the highest priority include: Prevention of oxy-hydrogen in steam systems, diversified reactor vessel level measurement, monitoring of safety function status, improved operational decision system, analysis of non-redundant safety systems (e g primary system) and improved fire safety and security.

- **Ringhals 1-4**

The plant renewal programme for the Ringhals plant (Ringhals Development Program 1997-2001) was initiated in 1997 and the first phases of the programme have been completed. During the time period since the previous national report the following major modernisation items have been implemented:

- Remaining parts of the SPRINT project (replacement of primary system piping) completed (R1)
- Verification and improvement of piping supports (R1)
- Exchange of control rod indication and manoeuvering system (R1)
- Introduction of alarm for core instability (R1)
- Separation of electric power supply of core cooling systems (R1)
- Improvements in fire protection systems (R1, R2, R3, R4)
- Improvements of the safety valves of the pressuriser (R2, R3, R4)
- Replacements and improvement in the electrical supply systems for improved separation and safety (R2)
- Modernisation of the radiation monitoring system (R2, R3, R4)
- Modernisation of the safety injection pumps including vibration monitoring (R3, R4)
- Upgrading with redundant cooling of the charging pumps at shut-down (R3, R4)

- Modernisation of vibration measurement/monitoring of the reactor coolant pumps (R3, R4)

- Introduction of cavitation alarms on the residual heat removal pumps (R3, R4)

For the future modernisation programme, a more restrictive investment policy will be applied. Some previously contemplated modernisation items aimed mainly at maintaining or improving plant availability have been modified or postponed, while the activities directed towards nuclear safety enhancement have been given priority. One major on-going modernisation project is the so-called TWICE project, in which the instrumentation and control equipment, including the main control room, of Ringhals unit 2 is being upgraded to current standards including improved system separation and independence. New requirements known at the time of project specification will be met. The future safety enhancement programme will be influenced by the new back-fitting guideline and a new firm long-term investment programme will wait until this guideline is in force.

6.4 Monitoring of effects of the deregulation of the electricity market

At the first review meeting under the Convention, Sweden was asked to present in its next report how the effects on safety of the deregulation of the electricity market are monitored. This section summarises this situation.

Deregulation of the electricity market has by now been in effect in Sweden for about five years and has had an obvious effect on both the market and the actors. A significant reduction in electricity prices took place initially as the market was deregulated. Contributing to this was that deregulation coincided with a period of time when the access to water in the hydropower basins has been extremely good in the Nordic countries. Since there is no direct way for the producers to transfer costs to the customers, a substantial pressure to reduce costs has resulted. This in turn has resulted in activities within the utilities such as reducing the number of personnel, outsourcing support functions, optimising processes and organisation and seeking the most cost-effective solutions in all cases. It also makes it important to keep production up at times when consumption and price are high (wintertime in Sweden), while longer stops can be tolerated, in the summer. Another effect has been a restructuring of the electricity industry, with mergers and acquisitions among companies internationally, towards a structure with a few very large actors both among the utilities and the suppliers.

Measures taken by the license holders

Actions, such as those mentioned above, have been taken at all nuclear power plants in Sweden and programmes have been carried out to reduce costs. The number of employees has in general decreased, as shown in chapter A 4, although in part compensated by an increase of contractors in out-sourced functions. The restructuring of the utility industry also requires investment capital, which reduces the financial

resources for investment in the plants. The new financial situation has caused the modernisation plans to be revised and slowed down. The strategy followed by the utilities is to put a priority on maintaining and enhancing the safety of the plants, while the investments for production increases and availability improvements are reduced or postponed. Measures to monitor and prioritise safety are further described in chapter 10.

It should be noted that the strategy to prioritise safety is enhanced by the fact that prolonged stops due to safety deficiencies, especially during high price periods, tend to be costly for the utility and must thus be avoided. Since cost cannot be directly transferred to the customer via the price, unsatisfactory safety represents a business risk which must be counteracted through high quality safety management.

In the process of cost reduction, fulfilling all safety requirements and maintaining a programme for safety improvement has been the primary concern in accordance with the adopted safety policies. No indication of degenerated safety has been observed during the past three years, based on the safety indicators monitored, and on the incident reporting system. One consequence of the new economic conditions is, however, that the importance of stable and well-defined regulatory requirements as a basis for long-term investments has become evident. It is expected that the new safety regulation of SKI will meet the need in this respect. As reported in sections 18.1 and 18.2, a dialogue between SKI and the utilities is in progress with the aim to reach an understanding on the guidelines for achieving an appropriate safety level for operation in the coming decades.

One aspect of the staff reductions and other effects of deregulation, which has to be monitored closely, is the availability of nuclear specialists. Reviews have been carried out in this area and have concluded that the competence and experience needed for safe operation of the plants is sufficient at present. In some areas it is anticipated that action will be needed to secure a sufficient number of competent and experienced people in the years to come.

Measures taken by the regulatory bodies

In the opinion of SKI and SSI, the development described above has so far not resulted in any degradation of safety at the Swedish nuclear power plants. It is observed that safety investments are made, although more slowly than thought some years ago. It is also noted that the utilities actively monitor their safety performance and safety culture. In this respect there is a consensus with the utilities. On the other hand, the development has created some regulatory concerns and it is felt that the regulatory environment today is somewhat different, compared to the earlier ”dialogue model” practised in Sweden since the beginning of the nuclear programme. This has to do with the following trends, observed during the recent years of regulatory supervision:

- There are more frequent changes in owner structure and internal organisation of the industry
- Investment programmes are delayed or split and decisions taken for shorter time periods
- There are large cost cutting programmes implemented in operations and maintenance

- Plant functions are to an increased extent merged, outsourced or downsized
- Operations and maintenance are optimised in relation to market conditions
- Larger effort is required of the regulator in the dialogue with the licensees and contacts are becoming more formal.

These trends and their possible further development have caused regulatory concerns such as

- A general more short term management policy at the plants
- A slower implementation of back-fits, for instance as a result of updated PSA studies
- Harder pressure on key plant staff
- Difficulties to keep up with deadlines for corrective measures at the plants
- More difficult to agree with the utilities on new regulatory requirements.

This situation sets new demands on the regulatory work and oversight processes. However, the development of regulatory requirements and practices, over the last years, has provided the basic instruments needed to deal with the new situation:

- A set of regulations with clear requirements on the safety management of the licensees including strong provisions on competence, quality management and self inspection (see chapters 8, 11, 12 and 13)
- Legally binding requirements on the development of safety as a result of ongoing safety analyse, operational experience feedback, and research and development (see chapter 9)
- Legally binding requirements on assessment from the safety point of view of organisational as well as technical modifications of fundamental importance (see chapters 8, 12 and 14)
- A modern quality management system for regulatory activities ensuring consistency and predictability of the regulatory bodies (see chapter 8)
- New regulatory processes for monitoring the safety performance of the licensee (see chapter 7)
- A new more efficient inspection process (see chapters 7 and 8)
- A stronger focus on top management meetings between SKI and the licensees (see chapter 10).

In addition, SKI has concluded that the regulatory body needs to define more clearly the requirements on back-fitting of the operating reactors during the remaining operating time. For this purpose it is planned to issue guidelines (see section 18.1).

In summary the regulatory bodies have concluded that the role of the regulator has become more important. More senior management involvement is needed in the dialogue with the licensees. The regulators need to be more transparent, clear and flexible. The regulators need to develop more efficient tools for monitoring the safety performance of the licensees. Research and development support of the regulators is important in order to develop new knowledge, for instance about the effects of economical pressure on safety organisations, and regulatory tools. International co-operation between regulators is increasingly important in order to exchange experience and to compare the different national requirements. It will be necessary to address harmonisation of national requirements, as the nuclear industry becomes more international.

6.5 Assessment of further operation

The safety assessments made so far, results from the design basis reconstitution projects mentioned above, and completed or planned modernisation measures, indicate that the Swedish reactors could continue to operate with a high safety level for their design lifetime of 40 years. One important condition for this is, however, that the systematic preventive safety work continues on a high level, taking into account all relevant operating experience and the development of new knowledge, and that the necessary human and financial resources continue to be allocated despite changing external conditions. So far the experience in Sweden shows that strong systematic safety work, with a continued reassessment and development of earlier safety analyses in the light of operational experience and new knowledge, can identify and make possible corrective measures in design and operation before any serious incidents and accidents occur.

6.6 Conclusion

The Swedish Party complies with the obligations of Article 6.

7. Article 7: LEGISLATIVE AND REGULATORY FRAMEWORK

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 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. Since the first report to the Convention was issued, the following amendments have been made in the legal framework with relevance for nuclear safety and radiation protection:

The Environmental Code

This general environmental law entered into force 1 January 1999. Its objective is to support a sustainable development thereby ensuring a healthy environment for current and coming generations. The Code includes general provisions on environmental protection and applies to all activities, which are important for its objective. Hence, the Code also applies to nuclear activities in parallel with the Act on Nuclear Activities. Nuclear facilities needing a license according to the Act on Nuclear Activities must also be assessed against the Environmental Code, and this shall be done simultaneously and in co-ordination. Nuclear activities are hazardous according to the Environmental Code. This means that all such activities must also have a permit from an environmental court. 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. This approval

must be given before an application according to the Act on Nuclear Activities can be examined. The rules on supervision according to the Code also apply to nuclear activities. The county administrations are supervisory authorities. A number of Ordinances issued under the Environmental Code also apply to nuclear activities.

It is clear that the licensing of nuclear facilities has become more complex since the Environmental Code came into force. For plants already licensed the new rules apply for instance when a new owner applies for transfer of the old license. The authority of SKI and SSI as nuclear regulatory bodies is not affected by the Environmental Code. However, the regulatory bodies need to liaison with the environmental authorities in a number of cases.

Amendments of the Act on Nuclear Activities

The Act (1984:3) was amended again 1 January 1999 with provisions connecting to the Environmental Code. In the licensing of nuclear activities, the general rules as well as the environmental norms of the Code apply. In addition, a license application shall always include an Environmental Impact Assessment. SKI can also require such an Assessment in other applications, according to the Act.

The additional protocol 22 September 1998 to the Non Proliferation Treaty has also caused certain changes in the Act on Nuclear Activities.

Amendments of the Radiation Protection Act and Ordinance

As a result of the EU directive 96/29/Euratom, a few amendments have been made in the Radiation Protection Act (1988:220). The minimum age for radiation work has been increased to 18 years. Some exports of radioactive material require a permit. A permit is also explicitly required for the disposal, recycling or reuse of certain radioactive material. The Ordinance on Radiation Protection has also been slightly up-graded with respect to work to be done by the competent authorities in connection with the supervision and control of the shipment of radioactive waste (Directive 92/3/Euratom) and the shipment of radioactive substances between Member States (Regulation Euratom 1493/93). It was also stated that SSI has to establish a national dose register. Such a register for nuclear workers has existed for many years in Sweden. However, in 2000 SSI has formally introduced a national dose register for all types of radiation work in Sweden.

Amendments of the Atomic Liability Act

From 1 April 2001, Sweden has raised the liability amounts for civil liability against third parties according to the Atomic Liability Act (1968:45). The liability of a Swedish licensee is increased to 3.3 billion SEK. In addition the Swedish state pays up to 6 billion SEK if the damage originates in the Nordic countries.

7.2 National safety requirements

SKI regulations

The new general safety regulations of SKI "Regulations concerning safety in certain nuclear facilities" (SKIFS 1998:1) entered into force on 1 July 1999. The first report to the Convention includes a presentation of the main contents of these regulations. Other regulations formally issued by SKI since the first report to the Convention are:

- Regulations concerning the competence of Operations Personnel at Reactor Facilities (SKIFS 2000:1)

These regulations, in force since 1 January 2001, include provisions for the analysis of competence requirements, 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. Due to their importance, for operational safety, specific regulations have been issued for these categories. 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. Attached to the regulations are General Recommendations concerning their application.

- Regulations concerning mechanical components in certain nuclear installations (SKIFS 2000:2)

These regulations went into force 1 April 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.

Other SKI regulations decided and planned for issue in 2001 and 2002 are the following

- Safety in final repository of nuclear waste
- Physical protection of nuclear facilities
- National non-proliferation control
- Safety in transport of nuclear material and nuclear waste
- Safety of nuclear fuel and core management in reactor facilities
- General recommendations on the application of SKIFS 1998:1 regarding design and construction of reactor facilities (back-fitting guidelines)

SSI regulations

Some changes have been made in SSI regulations since the first report to the Convention. At the end of 2000 there were a total of 45 SSI-regulations in force, covering all areas of radiation. 14 of these are directly applicable to the nuclear industry. A list of the new regulations introduced since 1998 specifically for the nuclear industry is presented in section 15.1. Many of these regulations have been adjusted in accordance with new radiation protection legislation of the European Community. All the SSI regulations and requirements have to be in agreement with international recommendations. Adjustments due to new standards have been carried out timely before the corresponding directives came into force. The Swedish regulations had to be in line with BSS before 2000-05-13. As a result of these changes and due to a need for modernisation and coherence some other regulations have also been revised.

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 10 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

Over the last two years, SKI has developed its inspection practice as a result of the new general safety regulations (SKIFS 1998:1). These regulations have made it possible to adopt a more structured approach to inspection and safety assessment. Major modifications from earlier practice, described in the first report to the Convention, are

- Only one type of inspection is carried out, i.e. topical inspection with a team of experts, to find out the licensee´s compliance with relevant regulations. These inspections are documented 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 the deviations and a proposal on further regulatory action. Careful planning is needed for these inspections documented in an inspection plan.

- Earlier routine inspections have been transferred to another manual and renamed ”covering of current plant issues”. The purpose with this practice is to be kept generally informed about activities at the plants, to collect information about plans, status of ongoing projects, etc. Another purpose is to have a practical possibility to detect early signs of deteriorating 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.

Regarding safety assessment, SKI has over recent years 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. The practice of SKI-Forum is still under development and is beginning to find its form.

These new practices are documented as manuals in the new quality management system of SKI (see further section 8.3).

SSI practices

In recent years, SSI has also 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 kind of official actions and standpoints that SSI has to deal with are collected in an internal quality management system. Essentially three types of regulatory routine inspections are performed: systematic inspections (regular or routine), specific inspections and topical inspections. These inspections are briefly explained below. Other types of inspection can be used in special cases.

- **Systematic inspection (regular or routine)**
  This inspection is aimed to be an overall inspection of the quality assurance system of the licensee, where organisation, administrative routines, co-ordination within the organisation, responsibilities and competence of the licensee are checked.

- **Specific inspection**
  This inspection is only focussed on a part of the activities of the licensee such as incidents where unexpected and significant occupational exposures have or might have occurred, or technical modifications that have to be inspected and approved.

- **Topical inspection**
  A topical inspection consists of a number of specific inspections that are performed in co-ordination at a number of similar facilities and with a joint theme. These inspections are usually performed by a group of inspectors. An example is to follow up on requirements about criteria, content and performance of radiation protection training. Another example is inspection of radiation protection programmes and their objectives (ALARA-programmes).

7.5 Conclusion

The Swedish Party complies with the obligations of Article 7.

8. Article 8: REGULATORY BODY

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 requirements of the two nuclear regulatory bodies in Sweden; the Swedish Nuclear Power Inspectorate (SKI) and the Radiation Protection Institute (SSI). Only minor changes have taken place in the last years.

The **SKI** organisation and its missions and tasks are basically unchanged. The organisation is shown in figure 3.

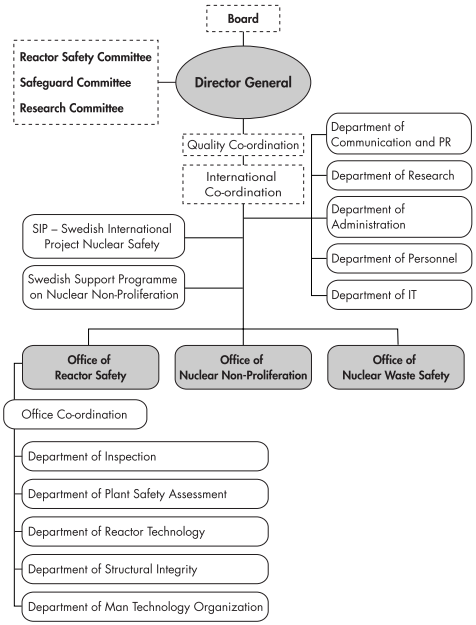

Figure 3. The SKI organisation.

Co-ordinators have been established under the director general for quality management and international activities. In addition, a co-ordinating unit has been established under the office director for reactor safety in order to co-ordinate larger projects within the office and to deal with some of the international work of the reactor safety office, mainly on the policy level.

SSI was reorganised in 2000. The present organisation is shown in figure 4.

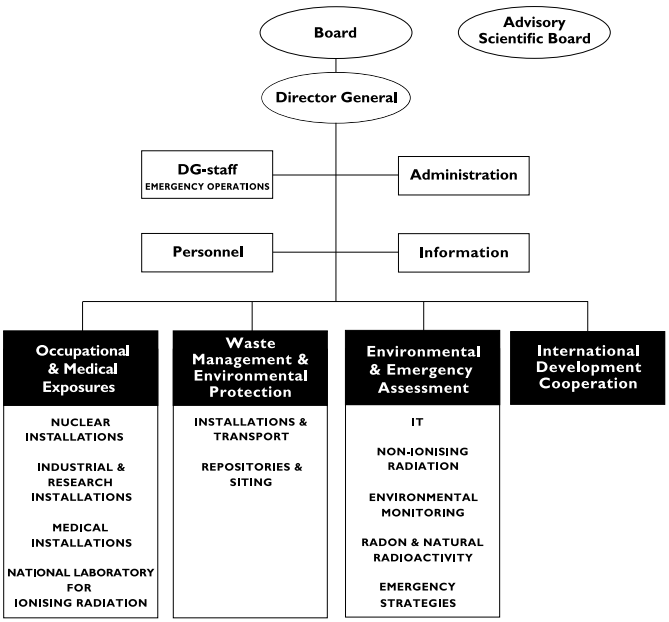

Figure 4. The SSI organisation.

There are now three main departments:

- **Department of Occupational and Medical Exposures** with sections for
  - Nuclear Installations (supervision of radiation protection and other site related radiological issues)
  - Medical Installations
  - Industrial & Research Installations
  - National Laboratory for Ionising Radiation

- **Department of Waste Management & Environmental Protection** with sections for
  – Installations & Transport (supervision of releases from nuclear facilities and environmental control of the nuclear sites).
  – Repositories & siting (supervision of intermediate and final disposal of radioactive waste)

- **Department of Environmental & Emergency Assessment** with sections for
  – IT
  – Non- ionising Radiation
  – Environmental monitoring (general measurements of radioactive occurrence in the environment)
  – Radon and Natural Radioactivity
  – Emergency Strategies (strategies for emergency planning of the Swedish nuclear power reactors as well as for foreign reactors in the vicinity of the border)

The Instruction for SSI has been updated 2000 but without any major changes in its missions and tasks.

8.2 Human and financial resources for regulatory activities

Staffing

SKI presently (2000) has a staff of 117. This is a slight increase since 1998 (111). Of these, 48 belong to the Office of Reactor Safety, thus dealing with supervision of the 11 operating nuclear power reactors, the research reactor and the fuel factory. 41% of the staff have more than 10 years of regulatory experience and 22% have worked for SKI for more than 15 years. This is an important factor in ensuring continuity in the regulatory work . The SKI staff turnover was 4 % during 2000, which is a rather normal figure.

SSI presently (2000) has a staff of 108. This is a slight decrease in the total number of employees from the earlier reporting period (121). However, the number of SSI staff dealing with supervision of the nuclear fuel cycle has not been reduced (27).

Earlier audits of SKI indicated that the workload of the staff was very high and that most resources were needed 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 first report to the Convention, resources were increased in 1997 allowing the recruitment of some additional experts. The working situation has now improved. The new resources, together with new supervision procedures and the activity planning system launched a few years ago, make objectives and resources match better than before. Staff surveys also show that the work situation is satisfactory even if it could be further improved, i.e. through more clear priorities in cases of conflicting demands on the staff. The work to improve the management system continues to that effect.

The high educational level of the SKI and SSI staff, mentioned in the first report to the Convention, has been retained in the staff turnover during the latest years.

Economical resources

As mentioned in the first report to the Convention, the nuclear 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 2000 are shown in the table below as compared to 1998.

Appropriation	SKI total		SSI total		SSI – supervision of nuclear power plants		SSI – emergency preparedness	
Year	**2000**	**1998**	**2000**	**1998**	**2000**	**1998**	**2000**	**1998**
Administration	82 648	76 279	73 800	78 645	21 900	19 641	13 200	15 583
Research	65 969	63 950	14 400	12 000	7 000	8 000	2 000	500
Total	**148 617**	**140 229**	**88 200**	**90 645**	**28 900**	**27 641**	**15 200**	**16 083**

Table 5: Budgets of SKI and SSI in KSEK. 1 SEK is about 0.1 USD.

As can be seen in the table the resources for nuclear supervision have increased somewhat since 1998.

8.3 Regulatory reactor safety research

In 2000, the SKI research programme was evaluated by a committee, with members from within and outside of SKI, and recommendations were given on the future direction of the programme. A new research policy has been decided aimed at a closer connection between the future regulatory challenges of SKI and the research programme. The following objectives have been established for the research in all technical areas within the programme:

- The research shall be proactive to the extent that there are effective methods and tools and sufficient knowledge to assess the safety level at any given time and to ensure that sufficient safety margins are in place.

- The research shall be conducted in such a way that enables SKI to have access to the competence and resources necessary in order to assess the safety level at any time and to ensure that sufficient safety margins are in place.

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

- The research shall be conducted in such a way that enables SKI to be up to date on the international development of reactor safety with special emphasis on safety principles for existing and new reactor designs.

- The research shall be conducted in such a way that enables SKI to participate in the development of reactor safety standards and practices which take place in international co-operation between regulatory bodies and in European and international contexts.

The reactor safety research is based on the fundamental safety principles for nuclear facilities, i.e. barriers and defence in depth, and is conducted by contracted university departments and companies within the following areas:

- Integrated Safety Assessment
- Safety Analysis
- Human Factors
- Structural Integrity
- Thermal Hydraulics
- Nuclear Fuel
- Severe Accidents
- Process Control
- Emergency Preparedness

In general the research budget has been found to be sufficient for SKI needs, but there is a problem with imbalances in the budget between different years due to difficulties in starting and finishing projects within the planned schedules. This has to do with the nature of research as well as busy schedules for the experts ordering and following the work and difficulties in some cases to find the necessary independent competence. As mentioned above, SKI finances two professorships and a number of post-graduate students in order to create and maintain such competence. In many cases, SKI also contracts foreign institutions for research and development work.

The Government has asked SKI to submit a report on the future research strategy by 31 December 2001 at the latest. This strategy shall take into account the regulatory needs, and also include an assessment of the future national competence demand and how this could be satisfied. The possibilities of international

co-operation shall be taken into account here. To develop this document, a survey of the national competence demand will be necessary (see further section 11.5).

8.4 Current development of the regulatory bodies

SKI

Over the last few years, SKI has devoted considerable effort to develop its regulatory processes and practices as a consequence of the decision taken in 1997 to develop and implement a new quality 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 QM-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
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)

At present (June 2001) 14 of the documents have been approved and formally issued by the SKI director general. The rest of the documents are planned for issuing before the end of 2001. The documents are available to all staff through the intranet and there are plans to develop computerised working tools directly related to the process descriptions (document templates, direct links to reference material etc). The implementation of the entire system will considerably contribute to enhance the transparency and consistency of the SKI decision making.

As mentioned in section 7.4 the issuing of the general safety regulations (SKIFS 1998:1) and associated general recommendations has strongly influenced the development of the inspection and safety assessment practices. These regulations, containing within one document the basic safety requirements on the licensees for major nuclear installations, have enabled a structured approach in the regulatory supervision. It is now easier than before to specify which requirements have been followed up in an inspection or a safety review and to clarify the nature and significance of the observed deviations. In order to further enhance a consistent approach among SKI staff, in interpretation and application of the regulations, five assessment guides are under development dealing with the following general issues appearing in most inspections:

- quality management in general
- quality audits
- safety review (primary review and independent review)
- resources/competence for task important to safety
- investigation of events and experience feed-back

Further assessment guides are planned depending on experience.

SSI

The profile of SSI, as the dedicated Swedish authority for environmental protection with special responsibility for radiation protection, has been more pronounced during the recent years. A new policy has been introduced regarding inspection of most activities covered by SSI regulations. Extensive work has been done to revise old regulations and issue new ones. For instance, during 2000 twelve new regulations have been issued. As a result of new regulations a national dose register administered by SSI has been introduced. All personal dosimeter services, which perform category A-dosimetry in Sweden, have also been examined and approved.

Another current issue for SSI is to prepare for the decommissioning of nuclear facilities. Extensive preparatory work has been done in 2000 with a view to introduce new radiation protection regulations regarding decommissioning.

8.5 Experience gained from the new safety regulations with regard to higher requirements placed on the licensees own control over safety

At the first review meeting under the Convention, Sweden was asked to present in its next report the experience gained from the implementation of the new SKI safety regulations, especially with regard to the higher requirements placed on the licensees´own control over safety.

The principles and logic behind the new safety regulations (SKIFS 1998:1), which came into force on 1 July 1999, reflect the current nuclear regulatory philosophy in Sweden. In the regulations, three different control principles are used

- **Approval** from SKI of the basic licensing documentation is required. This documentation is specified in the regulations: the final safety analysis report, the technical specifications, the emergency preparedness plan and the physical protection plan. A decommissioning plan must also be approved by SKI. In these cases and in other cases where an application is submitted, according to the Act on Nuclear Activities, SKI performs an in- depth technical review.

- **Notification** to SKI is required regarding all principal modifications in the mentioned documentation and in the plant itself. These modifications shall be subjected to a twofold safety review by the licensee before SKI is notified (see further section 14.1). The safety review minutes shall be included in the notification. As soon as SKI is formally notified, the licensee is allowed to implement the modification. SKI is free to decide whether to review the notification or not. In all cases further or other conditions can be imposed on the modification.

- SKI does not routinely interfere in any other safety issues. These are controlled through **self-inspection** by the licensee. This self-inspection shall be supported by a strong quality management system, including a strong system for primary and independent safety reviews, subject to regular internal

audits. SKI supervises the quality of the self-inspection. Incidents must of course be reported as described in section 19.1.

In addition to the three basic control principles there is a fourth principle concerning **third party control** in the SKI regulations on mechanical components (SKIFS 2000:2). This has, among other things, to do with the requirement to use non destructive test methods qualified by an accredited inspection body and that such a body certifies the achieved results.

Previously Sweden applied the same procedure as most other countries such that all plant modifications and modifications of the SAR and of the Technical Specification document must be submitted for approval by the regulatory body. A reason for changing this in Sweden was a clearly felt need to concentrate the regulatory review resources on the most important issues for safety. The notification procedure allows this, but still maintains control over the modification activities of the licensees. Another reason was to make the responsibilities for safety more clear.

There are at least two fundamental prerequisites needed in order for a system with notification and self-inspection to be acceptable to the regulator. The first is a very clear nuclear law concerning the responsibility for safety. The Swedish Act on Nuclear Activities is very clear that the licensee has the total and undivided responsibility and must take any initiative, which might be needed to maintain safety. The other prerequisite is that the regulatory body has confidence in the capability of the licensee for self-inspection. It must be verified that adequate resources, competence and work practices are in place.

There are now about two years of experience with the new system. It is evident that the expectations between the licensees and the regulator did not match completely from the beginning.

The experiences of the regulator can be summarised in the following way:

- It has been necessary to adapt the SKI internal practices to the new regulations. A standing group of experts from different 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.
  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.

- After some initial problems, the notification routines are running smoothly. Occasionally SKI has returned notifications to the licensees with a request for more information in order to decide to review or not. In a number of cases SKI has not been satisfied with the quality of the safety reviews submitted. However, the general experience is that the quality has improved with time, and is now satisfactory.

- It has been necessary to clarify with the licensees what kind of modifications fall under the obligations to notify. In particular this has been the case with organisational changes. SKI has clarified this in a memorandum[9]. Organisational changes with principal implications for the management and control of the activities must be submitted as a notification, e.g. outsourcing of safety related activities, substantial downsizing, merging of production units, etc.

- 230 technical and organisational notifications were submitted to SKI in 2000. In addition SKI was notified about a number of temporary exemptions from Technical Specifications. 53 of the notifications resulted in a review by SKI. In a few 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.

- In the opinion of SKI the objectives with the new system have been attained, even if further fine-tuning is needed. More notifications have been reviewed than originally planned (10%) but this is normal when launching a new system. The review of organisational modifications has taken extra effort since there was no earlier practice to rely on. In a number of cases SKI has been faced with very late notifications. In a few of these cases, the licensee received further conditions after having started the implementation. However, it is a clear interest for both parties to allow SKI the necessary time to make the first assessment. This issue will be further discussed with the licensees. One follow up meeting has so far been held with the licensees and it showed there to be general satisfaction with the system. The responsibilities are clearer and it is felt that the extra paperwork needed for SKI has decreased, and the response time of the regulatory body is much shorter than before.

- In order to assess the capabilities of the licensees for self-inspection, SKI completed in 2000 extensive inspections of the safety review functions of all the nuclear facilities. The general impression was that primary and independent safety reviews were conducted in a competent way but in some cases not completely satisfying regulatory requirements on documented procedures. Corrective measures have been taken to that effect.

- In summary: so far SKI has good experience of this new regulatory strategy. However, one conclusion is that it is important for the regulator to continue the activity oriented inspections in order to verify that adequate resources are maintained for self-inspection and that adequate procedures are in place.

[9] SKI-PM 99:14 (in Swedish).

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. The Government and the regulatory bodies work under transparency, which means that decisions and documentation are open to the public. 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 report to the Convention and in chapter 8, the Swedish Act on Nuclear Activities is very clear about the prime responsibility for safety:

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.

The new safety regulations (SKIFS 1998:1) further clarify this responsibility through strong provisions 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, § 3 point 8) that safety shall not only be maintained but also be developed continuously. 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.

9.2 Measures taken by the licence holders

A number of measures taken by the licence holders to fulfil their responsibility were mentioned in the first report to the Convention: safety policies, maintenance and back-fitting measures, design reconstitution projects and plant modernisation programmes, international experience feed-back, research and development work and corrective measures.

During the last three years, activity has continued in all these areas with the purpose of maintaining a high technical and safety standard in the Swedish nuclear power plants. As described in sections 6.3 and 6.4, the deregulated electricity market has had a significant influence on the financial prerequisites for the investment programmes of the utilities, and several of the modernisation programmes have been adjusted to reduce costs. These adjustments have mostly been directed towards projects to increase output and availability, while investments to maintain and develop safety are given priority. Regarding safety-related investments, the importance of well defined and long-term stable design requirements has been emphasised. Work is going on both in the regulatory body and the utilities to define a new guide for nuclear safety in coming decades, as is further described in sections 18.1 and 18.2 of this report.

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 general safety regulations SKIFS 1998:1 are quite explicit regarding priority to safety:

> ”The licensee shall establish documented guidelines for how safety shall be maintained at the facility as well as ensure that the personnel performing duties which are important to safety are well acquainted with the guidelines” (Chapter 2, § 3, point 1).

The meaning of the paragraph is further clarified in the general recommendations to the regulations:

> ”Guidelines for safety are the safety policy and the safety goals which determine the direction of work important to safety, as well as a strategy describing how the goals are to be attained. The safety policy should be tangible and demonstrate a high level of ambition with regard to ensuring priority to safety. The safety goals may be both quantitative and qualitative. The goals should be formulated so that they can be followed up”.

Another provision in SKIFS 1998:1 is relevant for the obligation of Article 10:

> ”The licensee shall ensure that decisions on safety-related issues are preceded by adequate investigation and consultation so that the issues are comprehensively examined” (Chapter 2, § 3, point 3).

In the general recommendation to this paragraph, it is mentioned that in order to ensure adequate investigation and consultation, in addition to the provisions on safety review, a safety committee should be established with the aim of functioning as an advisory group with respect to safety. The committee members should have a high level of integrity and a broad competence regarding nuclear safety issues.

10.2 Measures taken by the licence holders

Safety policies

The safety policies issued by Vattenfall AB and Sydkraft AB are the highest level documents expressing the most important corporate values regarding nuclear safety and are valid for all divisions and subsidiaries of each company. The values of the corporate policies are interpreted and further developed in the safety

policy documents of each nuclear plant manager. The policies have remained essentially unchanged since the first report to the Convention in which the policy of Sydkraft is illustrated.

Safety management provisions

As described in the first report to the Convention, the management system of the utilities includes several instruments used to give priority to safety, e.g. safety policies, safety advisory committees, strategic development plans, safety monitoring systems including safety indicators, technical specifications and procedures, quality systems comprising procedures and tools for verification of safety. The development during the previous period can be summarised in the following points:

- As mentioned in the previous report, the first priority of safety in all decisions is established in the safety policy of each licence holder and is interpreted and guidelines defined for explicit guidance at various organisational levels.

- In the Vattenfall as well as the Sydkraft groups, a safety council on the corporate level monitors how the policy is implemented and advises the management as to how the policy could be further developed and improved. In the Vattenfall safety council, the managing directors and safety managers of the plants are members, as well as the director and nuclear controller of the corporate asset management staff. The chair is held by the corporate director of generation. The Sydkraft approach is somewhat different with the R&D director chairing the council meetings. Plant representatives include the managing director of the plant who is accompanied by senior nuclear experts, two of whom are from outside the Sydkraft group.

- At each plant current safety issues are reviewed by a safety committee led by, or advisory to, the plant manager. In these committees policy issues as well as plant modifications, operational events etc. are handled.

- As mentioned in the previous report, each plant has a strategic development plan, where safety improvements are defined and given priority according to the policy and guidelines. The content of these plans has been developed successively to become a comprehensive safety improvement programme for each plant. The plans are revised annually in accordance with the new safety regulations SKIFS 1998:1.

- The level of safety in plant operation is monitored in several ways, one of the main instruments being performance indicators at several levels of the organisation using appropriate indicator sets. Further work has been on-going to develop the indicator instrument and to summarise the result in a safety index. One example of this is the indicator set and related safety index used by plants in the Vattenfall

group, which is illustrated in Figure 5 and which summarises performance in four areas: INES events, technical management, organisational issues and safety climate.

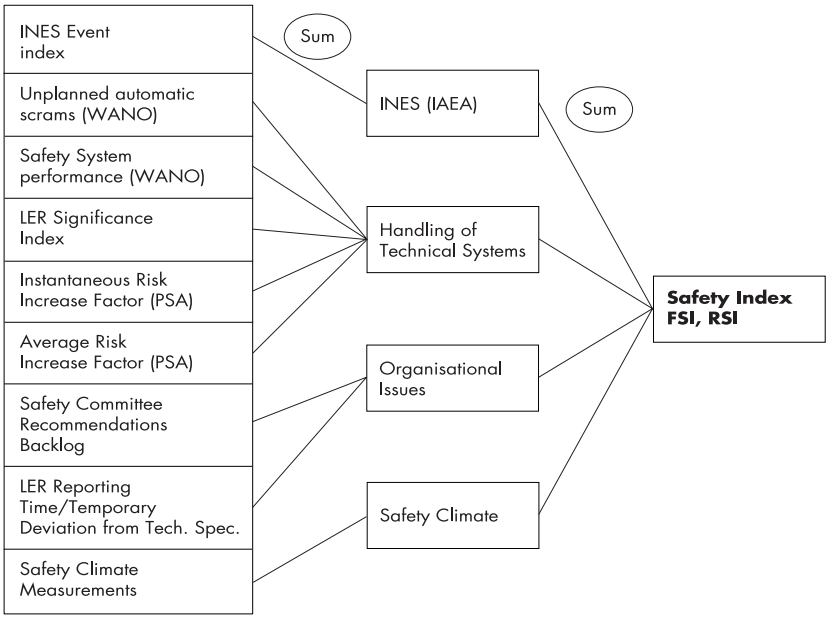

Figure 5. The Safety Index used in Forsmark (FSI) and Ringhals (RSI).

At Ringhals the above safety index (RSI) has been used as a management tool since 1998 together with an environmentally oriented index (RMI). In the RMI are included parameters such as personnel doses, radioactive releases to air and water and fuel damage. The inclination to report near-misses and observed risks is also measured and included to encourage safety consciousness and stimulate active improvement of working conditions and safety. The RSI and RMI are used to follow trends and detect needs for improvement and they are also included as a factor in the internal bonus system.

Safety culture programmes

A strong safety culture in the operation of nuclear plants is considered vital by the Swedish utilities and a number of actions have been taken to create and enhance safety culture, as was described in the previous national report. An update of actions taken during recent years is given in section 12.4 below.

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. In addition to the experience feed-back on technical matters and the reviews undertaken by international review teams in the IAEA and WANO framework, several initiatives to share and gain experience in safety management have been taken by the utilities. Two international reviews by qualified international teams were undertaken, by Vattenfall and Sydkraft respectively, in the middle of the nineties. These reviews aimed at identifying deficiencies in the safety management which had led to the so-called 5-reactor stop due to problems in the emergency core cooling systems in 1992-1993, see section 6.1 in the first national report.

Since the first report, Vattenfall has undertaken another review by a team of four internationally very experienced experts on safety management. This review was made using some novel features and comprised the complete management line from the chairman of the board to the operators at the plant. Several new insights were gained from the review and most of the recommendations have been implemented.

10.3 Regulatory control

The first report to the Convention mentioned a number of regulatory actions that had been taken in order to make sure that licensees give adequate priority to safety. These actions are still valid. During recent years the regular top management meetings with the licensees have gained more in ímportance as a result of the deregulation of the electricity market and associated new business climate. The director general of SKI and the office directors now meet with the management group of each nuclear power plant and other major facility 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.

As mentioned in section 7.4 the new practice of SKI-Forum has contributed considerably to the discussions with the top management of the nuclear facilities. SKI-Forum provides an updated comprehensive regulatory assessment of the safety of the facility. A management meeting is planned to follow each SKI-Forum.

SKI has also formally included in its surveillance arsenal a new instrument called ”special surveillance”, decided by the director general and applied in cases in which SKI is not satisfied with the safety performance of a nuclear facility, and this situation is not improving. It can also be applied for other special safety reasons, e.g. during testing operation after large plant modifications. The special surveillance regime means that inspections are made on a tighter schedule and special progress reporting is required of the licensee. Special surveillance has been applied in a few cases, most recently in connection with the closure of Barsebäck 1 and the modernisation of Oskarshamn 1. It is formally terminated when SKI is satisfied with the improvements made or the special safety reason is no longer valid.

10.4 Measures taken by SKI

One basic idea behind the new regulatory strategy of SKI, discussed in section 8.4, was to be able to concentrate the regulatory resources on the most important issues for safety. Experience so far shows that this can be done as a result of more flexible use of review resources. The new quality management system (SKIQ), described in section 8.3, and the activity planning system also support such priorities. The annual activity planning 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.

10.5 Conclusion

The Swedish Party complies with the obligations of Article 10.

11. Article 11: FINANCIAL AND HUMAN RESOURCES

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

It is clear from the Swedish Act on Nuclear Activities that in order to obtain a licence, large economical resources must be committed in order to manage the safety obligations mentioned in chapter 10. 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 of SKI (SKIFS 1998:1) are specific about the staffing of 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. 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.

The new regulations also contain provisions that the staff must be fit for their duties. This implies medical requirements and tests for drugs, etc. Such provisions have not been issued before by SKI, but how the licensee manages the fitness for duty issues has been inspected.

Since the first report to the Convention, new regulations and general recommendations concerning the Competence of Operations Personnel at Reactor Facilities (SKIFS 2000:1) have been issued. These regulations, also mentioned in section 7.2, contain requirements on training and authorisation of operations personnel. The authorisation system is administered by the licensee under the supervision of SKI. Authorisation is valid for three years under certain conditions, such as annual retraining and an annual check

[10] The average fee during 2001 is 0.9 öre/kWh. Required financial securities amount to 6.3 billion SEK. A special fee, at present 0.15 öre/kWh, must also be paid for the handling of old nuclear waste in Studsvik.

that central competence is maintained. Specific provisions on simulator retraining and annual working time are included for control room operators. SKIFS 2000:1 also includes a specific provision on an extended quality control of the system for training and competence evaluation of the operations personnel. These new regulations replace older licensing conditions and came into force on 1 January 2001.

11.2 Financial resources of the licence holders

The majority owners of the Swedish nuclear power plants are Vattenfall AB and Sydkraft AB, with ownership shares as shown in figure 1 of chapter 2. As mentioned there, the Swedish state is the sole owner of Vattenfall AB while the largest owner of shares in Sydkraft AB is the large German utility E.ON.

Both the Vattenfall Group and the Sydkraft Group are financially stable and have good financial records. Some key figures from 2000 are given in table 6 below.

Utility group	Earnings MSEK[11]	Total assets MSEK	Electricity sales TWH	Equity/Assets Ratio %	Investments MSEK
Vattenfall	5 189	115 005	83.1	35.3	23 840
Sydkraft	3 204	54 215	27.6	41	4 494

Table 6. Financial records of the utility groups in Sweden.
Note: The investments of Vattenfall are dominated by company acquisitions. Investments in tangible assets are 4426 MSEK. The corresponding figure for Sydkraft is 1450 MSEK.

During the three years since the first report, the deregulated market in the Nordic countries has generally resulted in low electricity prices. In combination with a specific tax on nuclear power, this has reduced the competitiveness of nuclear power in Sweden. So far the general impact on utility profits has been small but investments in improving availability and increased output have become less attractive. The restructuring of the utility industry also requires investment capital, which reduces financial resources for investment in the nuclear power plants. As mentioned in section 6.4, the current investment strategy is to put priority on maintaining and enhancing the safety of the plants, while the investment programmes for modernisation and availability improvements have been reduced or postponed.

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

Staffing situation

The staffing principles, described in the first report to the Convention, are still valid, however the general economic situation due to the deregulated market has had some consequences. The nuclear power plants

[11] Before taxes and minority share.

have been forced, among other things, to consider their personnel costs. The traditional large use of consultants has been reduced considerably, possibly due to the decreased number of modernisation projects. Plant employees have had to take over from the consultants. On top of this, early retirement has been offered to and accepted by many employees.

As can be seen in chapter 2, the plant organisations have been reduced by 70-120 individuals per plant corresponding to 10-16 %. As mentioned in the earlier report, the Swedish plant organisations were already earlier considered small compared to most other plants around the world.

Most of the outsourcing has concerned general service functions, such as housekeeping and canteen staff, but functions also indirectly important to safety, such as IT, archiving and training have been contracted out. However, these functions still remain located on-site.

Training of NPP staff

The first report to the Convention contains an extensive description of the organisation and structure of training at the nuclear power plants. This description is still valid. However, one major change has taken place.

Until 1998 all the seven full scale simulators (see table 7 below) were located in an integrated training centre in Studsvik operated by the jointly utility owned company KSU.

During recent years this training centre has been reorganised and the simulators have been relocated to the sites, except the Barsebäck and the Forsmark 3/Oskarshamn 3 simulators. The relocated simulators will still be operated by KSU, but the consequence will in some cases be that all education and training at the site, not only the simulator training, will be taken over by KSU on a contract. Competence to order and follow up on the contractor will, however, remain in the plant organisation. Except for the two remaining simulators the training centre in Studsvik will concentrate on the production of teaching material and instructor courses.

11.4 Regulatory control

The compliance with the requirements on competence assurance in the general safety regulations SKIFS 1998: 1 was inspected in 2000 at all nuclear power plants. These inspections showed a need for improved analysis tools, in order to define competence requirements, for other personnel groups than operations personnel for which a systematic approach has been used for several years. Work is going on at all the plants to improve the analyses, with a view to complete this during 2001. SKI continues to follow this issue.

The relocation of the simulators and outsourcing of all training activities have been subjected to safety review by the respective licensee and SKI has been notified of these changes. They are now under review at SKI.

Simulator	Target unit	In operation from
B1	Barsebäck 1 and 2, Oskarshamn 2	1975
R3	Ringhals 3 and 4	1978
FO3	Forsmark 3 and Oskarshamn 3	1984
F1	Forsmark 1 and 2	1990
R1	Ringhals 1	1991
O1	Oskarshamn 1	1993
R2	Ringhals 2	1995

Table 7: Swedish full scale simulators.

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 declining interest in nuclear engineering among students at the technical universities. This was attributed to the general declining future of nuclear power in Sweden. As a consequence a number of professorships in nuclear subjects at the universities were not renewed after retirement of the incumbents. This would make it even more difficult to recruit new qualified nuclear engineers to the power plants in the future, if no actions were taken. It was further mentioned that only limited effects had been seen so far and a number of initiatives were taken by the industry together with SKI to address the situation.

There are now some encouraging events regarding the supply of nuclear specialists. As mentioned in chapter A 4, there are decisions or advanced plans to maintain a number of professorships in specific nuclear subjects. An agreement is further under discussion between SKI and the nuclear utilities to support the university infrastructure for 3-6 years with basic resources in nuclear disciplines for both education and research. A number of post-graduate degrees have been issued the recent years in the nuclear topics. In addition a large number of articles, based on SKI sponsored research, were published in international scientific journals. The research of the Division of Nuclear Power Safety at KTH was awarded the year 2000 ”Technical Achievement Award” by the American Nuclear Society in the area Thermal Hydraulics, and was also given the ANS Prize for the best scientific publication in year 2000.

The situation with regard to the demand for nuclear specialists is somewhat easier today than it was three years ago, due to the reduced scope and prolongation in time of the modernisation programmes of the reactors. Some qualified nuclear specialists are available for other urgent projects. A potential problem in the future is, however, the high retirement rate over the next ten years.

It should be mentioned in this context that there are no difficulties so far to recruit other technical staff to the nuclear power plants, such as candidates to become control room operators.

A government committee made a survey in 1989-90 of the supply and demand in Sweden of nuclear engineers and other specialists with projections up to 2010. This study resulted in a number of recommendations to the involved parties. As a part of the work to develop a future research strategy for SKI, an updated study will be made on the supply and demand of nuclear specialists in Sweden. This study is scheduled to be completed in the middle of 2001. As mentioned in section 8.3 the research strategy shall be submitted to the Government by the end of 2001. The end result should be a long-term action plan to ensure the necessary nuclear specialist competence for the remaining nuclear operating time in Sweden.

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 Three Mile Island nuclear accident to implement the Human Factors concept, or MTO (interaction between Man-Technology-Organisation) as it is often referred to in Sweden. Several of the initiatives regarding plant design, safety management and organisational issues, discussed with the utilities, are now part of the general safety regulations (SKIFS 1998:1).

For instance, it is now a legally binding requirement on the licensee to ensure that the personnel of the nuclear installation is provided with the necessary conditions to carry out work in a safe manner. This means that any deficiency in the work conditions, which can have a detrimental effect on safety, should be corrected and, in order to identify such deficiencies, human factors analyses should be carried out and recurrent evaluations performed (Chapter 2, § 3, point 6).

With regard to design and construction it is also legally required that design solutions shall be adapted to the ability of the personnel to manage the facility in a safe way as well as to be able to handle abnormal events, incidents and accidents (Chapter 3, § 3).

The safety regulations have a general strong focus on safety management with provisions on:

- guidelines for safety
- quality management covering all activities important to safety
- adequate consultation before safety decisions are taken
- adequate staffing and staff competence
- well defined responsibilities and lines of authority
- investigation of events and experience feedback

It is further a legally binding requirement to take adequate action when deficiencies are detected in management and control of activities which could threaten safety. These must be investigated and a safety review performed in the same way as for technical deficiencies. As mentioned in section 8.4, there is also a legal requirement that organisational modifications of principal importance are reviewed from the safety point of view in the same way as technical modifications and SKI must be notified before they are implemented.

12.2 Measures taken by the licence holders

The MTO concept has now become a basic component in the nuclear safety work in all Swedish nuclear plants and is widely used in design and modernisation of control rooms and other equipment, in event analysis and trending, and in operator training. The MTO activities are supported by policies, responsibilities and organisational structures, which differ between the plants and the different subject areas. For generating human factor related experience by root-cause analysis of events and LERs, there are so-called MTO-groups at each plant to carry out the analysis. The MTO work at the plants is supported by specialists in MTO from universities or consulting organisations within or outside the owner organisation. Generally more actors are involved in the MTO area today than before.

R&D projects

As also reported previously R&D projects are conducted to support MTO-activities at the plants. Since 1998 the following new projects have been launched:

- A formula for safety climate surveys has been developed and is used at all plants. By this formula, based on questionnaires to all personnel, a measure of the safety climate (or safety culture) of the organisation is obtained, which can be used as a safety indicator.

- A project for development of methods for diagnosis of the robustness of the organisation and management systems for nuclear safety has been initiated by OKG and is presently in progress. In short, the method aims to identify and evaluate six important basic safety activities that need to function 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 are in progress in co-operation with university departments (Stockholm University), e.g. one investigating non-destructive testing from a human factors perspective and another analysing deficiencies with respect to operability verification.

12.3 Regulatory control

At SKI today the MTO-department participates in inspections, safety reviews and other regulatory activities completely integrated with the technical departments. The six MTO specialists are in great demand. After the general safety regulations came into force, much of the supervision work has dealt with assessment of management- and organisational aspects of changes in plant organisations and activities and assessments

of the systems of the licensees to assure staffing and competence. Inspections have also been carried out to make sure that the MTO groups of the plants have adequate staffing and competence.

Several of the reactor units are implementing large modifications to their control rooms in connection with replacement of the instrumentation and control systems. All stages of these projects are followed by SKI in order to make sure that the licensee adequately considers the MTO aspects. In connection with other large plant modifications, such as the upgrading of Oskarshamn 1, the quality assurance and safety review of the licensee are also inspected.

In connection with the mentioned operability verification incidents (see section 6.1) SKI has closely followed the work of the licensees to prevent further events of this type.

Notifications (according to SKIFS 1998:1) about changes in organisation and control of plant activities have been received during recent years from all licensees, for instance regarding implementation of process control of activities, centralisation of maintenance, outsourcing and downsizing. The quality of the notifications and associated safety reviews has varied. However, SKI has observed a general improvement in the capability of the licensees to assess the safety consequences of such modifications since the regulations came into force in 1999. In connection with reviewing these modifications SKI has had several meetings with the licensees to discuss specific modifications, and also a joint meeting with all licensees to discuss the general experiences with preparing, reviewing and implementing organisational modifications.

The SKI regulatory activities are supported by R&D projects. The following MTO projects are on-going:

- Analysis of factors influencing the performance of non destructive testing (together with the utilities)
- MTO aspects in operability verification (together with the utilities)
- Organisational rationalisation and safety
- Safe handling of organisational modifications

To support the supervision of decommissioning, SKI has launched research in order to collect and evaluate experiences from the closure of power plants in other countries and the closure of other kinds of industrial plants in Sweden. Three reports have been published from these projects.

As mentioned in chapter 4, SKI finances one professorship in nuclear safety and MTO at the Stockholm University. This effort has produced some new MTO experts employed by SKI and the nuclear industry.

12.4 Measures taken to enhance safety culture

During the last review meeting, Sweden and other Parties to the Convention were asked to present in their next report more about the measures taken by the industry and the regulatory bodies to improve the safety culture. This section summarises the Swedish situation.

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 at the different sites comprise the following items:

- As mentioned in section 12.2 above a safety climate survey has been introduced at all sites, whereby a measure/indication of the safety culture is obtained and negative trends can be identified and counteracted. The survey is made by a written questionnaire to be answered by each individual at the plant. By analysis of the answers, the needs for improvement can be attributed to different areas like leadership, individual, group, resources, relations, documentation, experience feed-back, etc. The survey is repeated periodically and new measures and programmes are initiated based on the outcome of the survey.

- 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 sessions 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.

- An associate professorship on human factors including safety culture has been created at Mälardalens Högskola, a regional university. The post will be dedicated to supporting research and education on human factors, learning organisations and safety culture. The professorship comprises 75% of full-time for 3 years and is sponsored by the Swedish utilities. An experienced MTO expert from the utility side has been appointed to fill the position.

- A development project in the area of learning organisations and including safety culture aspects in several parts is in a final state of planning. The project has participants from several European countries including Swedish nuclear plant organisations and will be supported by the European Union.

In its supervision, SKI does not actively use the word safety culture. However, many of the provisions in the general safety regulations (SKIFS 1998:1) deal with necessary prerequisites for creating a good safety culture at the plants. The primary task of SKI is to make sure that these prerequisites are in place. SKI fully supports all the mentioned efforts by the licensees to monitor and develop their safety cultures.

Regarding the regulatory body itself, the new quality management system (SKIQ) and its basic values according to the Swedish Quality Award clearly aim at creating a good company culture with complete

openness and participation. As mentioned in section 8.2, SKI also makes regular staff surveys to monitor the work environment and the workload of the staff.

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

As mentioned in the first report to the Convention, the new general safety regulations have, from 1 July 1999, replaced the previous general licensing conditions on quality assurance issued 1991. The new regulations can be summarised in the following points with regard to quality assurance:

- The licensee shall ensure that the activity of the facility is controlled and developed with the support of a quality system, which covers those activities which are important for safety.
- The quality system shall be kept up-to-date and be documented.
- The application, suitability and effectiveness of the quality system shall be systematically and periodically inspected by a quality assurance function, which shall have an independent position in relation to those activities which are to be audited.

The general recommendations to the legally binding requirements point out that in order to cover all activities important to safety, the scope of the quality system should not be too narrow. The IAEA Code and Guides for quality assurance are mentioned as guidance for developing the system. The recommendations also address the integrity and independent position of the audit function directly under the plant manager, the competence of the audit teams, the audit intervals and audits also of the QA-function and the plant management made by independent auditors.

The new regulations emphasise as mentioned that the quality system must provide for the development of the plant activities and contribute to the development of safety (Chapter 2, § 3, points 2 and 7)

13.2 Measures taken by the licence holders

Quality programmes

As was described in the first report to the Convention, the quality assurance programmes of the Swedish nuclear power plants have through the years become an integrated part of the total management system of every plant. As a consequence of this, continuous development has taken place. This has, for instance, resulted in the participation of the Barsebäck and Oskarshamn plants in the Sydkraft group internal quality

competition according to the Swedish Quality Award criteria. Both organisations have received recognition for their performance in the quality management area. Oskarshamn has gone one step further and will compete for the Swedish Quality Award 2001.

The development of ideas and knowledge from total management concepts, and the new standard ISO 9001:2000 for quality management systems, has lead to increasing work with processes and attempts to implement process-orientation in the organisation and daily work.

Another example of development over the last three years is the integration with environmental issues. A large amount of work has been put into life cycle analyses and on certification and auditing of environmental management. As a result both the Forsmark and the Ringhals plants have been certified according to the environmental standard ISO 14001 and are registered according to the EMAS (Eco Management and Audit Scheme) rules of the European Union. Furthermore, Vattenfall Generation has a Certified Environmental Product Declaration (EPD®) for Electricity produced in the nuclear power plant at Forsmark. Similar developments are going on in Barsebäck and Oskarshamn, with the view to becoming certified according to the environmental standard ISO 14001:2000 before the end of 2001.

The fact that Barsebäck Kraft AB now is a part of the Ringhals group has lead to a closer co-operation in all areas between these two plants. This merger will be further accentuated in the near future and work has already been commenced to achieve one mutual quality and management system for the plants with the ambition to use the best parts of the two systems.

Quality audits of suppliers

The environmental certifying of the plants automatically means that the suppliers are also required to be certified. This is normally not a problem since most suppliers already are. Apart from this no principal changes have been made in the programme as it was described in the first Swedish report to the Convention.

13.3 Regulatory control

The Quality Systems Evaluation Handbook mentioned in the first report to the Convention is now being updated according to the new safety regulations. Checklists are being developed for use in assessment of a quality system in its entirety as well as in assessment of specific applications. These tools have been tested in inspections and reviews of quality handbooks and in reviews of organisational modifications.

As well as for reviews of changes in quality management of the licensees, SKI has also recently assessed a quality management system as a whole and has also inspected the quality management of a major modernisation project (Oskarshamn 1). In addition, quality management is assessed to a certain extent in all SKI inspections, as mentioned in the first report to the Convention.

The quality audit plans of the licensees and the audit reports are also reviewed by SKI and annual meetings are held with the quality assurance functions of the nuclear power plants.

The extensive reviews made so far (one completed and one ongoing) of quality systems as a whole indicate that further discussions will be held between SKI and the licensees as to how to document the general activity control principles applied in the operating organisation.

13.4 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 reporting are collected in a separate chapter (chapter 4) of the new general safety regulations (SKIFS 1998:1). Many of these requirements are not new but were posed earlier as licensing conditions. Some of the requirements are, however, extended as compered to earlier conditions, and some are new. The legally binding requirements are summarised in the following points:

- A comprehensive safety analysis shall be done before a facility is constructed and before it is taken into operation. The analysis shall subsequently be kept up-to-date. The analyses shall be based on a systematic inventory of events, event sequences and conditions which can lead to a radiological accident.

- A preliminary safety report shall be prepared before a facility may be constructed and a final safety report shall be prepared before the facility may be taken into operation. The safety reports shall contain information as specified in the regulations. The preliminary and the final safety reports shall be reviewed as required, evaluated and approved by SKI. The final safety report shall be kept up-to-date.

- The licensees are required to conduct safety reviews in order to make sure that all relevant aspects of a safety issue have been taken into account and that all relevant requirements concerning the design, function, organisation and activities of a facility are met. The review shall be carried out systematically and be documented.

- A safety review shall be performed within those parts of the licensee organisation which are responsible for the specific issues. A safety review shall also be carried out by a safety review function, appointed

for this purpose and with an independent position in relation to the organisation responsible for the specific issues (a twofold review).

- After being taken into operation, the safety of a facility shall be continuously analysed and assessed in a systematic manner. Any need for safety improvement measures, engineering as well as organisational, resulting from such analyses and assessments shall be documented in a safety programme. This programme shall be updated on an annual basis.

- At least once in every ten years, a new integrated analysis and assessment of the safety of a facility shall be made. The analyses, assessments and the measures resulting from these shall be submitted to SKI.

- Engineered or organisational modifications to a facility which can affect the conditions specified in the safety report, as well as essential modifications to the report shall be subjected to twofold safety review (see point 4 above). Before the modifications may be implemented, SKI shall be notified and SKI can decide that additional or other requirements or conditions shall apply to the modifications.

General recommendations are issued on the interpretation and application of the requirements[12]. In these recommendations the safety analysis conditions are specified. It is also mentioned that both deterministic and probabilistic approaches should be used since they supplement each other.

A number of conditions are given concerning probabilistic analyses. As to the scope, the PSA should include an analysis of the probability of core damage (level 1), as well as the probability of releases of radioactive substances to the environment (level 2). Power operation, shut down and start up, outage and refuelling should be considered as well as all relevant internal and external hazards.

In Sweden probabilistic assessments have not been used in the licensing of the reactors. However, in recent years Sweden, influenced by other countries, has opened up the possibility for such discussions in the assessment of plant modifications. In the field of non-destructive testing, the new regulations SKIFS 2000:2 allow the application of risk-informed decision making. As mentioned in section 8.4, SKI is currently working with an extension of the general recommendation to SKIFS 1998:1 regarding the design and construction of reactors (back-fitting guideline). In the draft of this guideline, some general conditions are proposed for using risk-informed decision making.

Since the beginning of its nuclear programme, Sweden has had specific requirements on surveillance, testing and in service inspection to ensure that the operation and the material condition of the reactors comply with requirements and operational limits and conditions.

Legally binding requirements on surveillance and testing after maintenance to ensure operability are included in SKIFS 1998:1, chapter 5 on operations, where there are specific requirements on Technical Specifications (operational limits and conditions), procedures and maintenance.

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[12] In addition SKI has in a memorandum (SKI-PM 98:11 in Swedish) expressed its opinion on what should be included in a primary vs. an independent safety review.

As mentioned above 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 (see further section 7.2).

14.2 Measures taken by the licence holders

In the first report to the Convention, there is an extensive section about how the legally binding requirements are met by the licensees. This text is still valid, with the following additions relevant for the development in the interim.

Safety reports

Major updates of the FSARs for the older reactors have been made as a result of the design basis reconstitution projects (see section 6.2). One aim has been to produce new FSARs, which are completely updated and documented in a user friendly way.

Current development of the use of PSA includes optimisation of maintenance and in-service inspection.

Surveillance

Several analyses and development projects are in progress or have been completed to improve the reliability of the operability verification procedures as described in more detail in chapter 19.

In-service inspection

The system described in the first report is essentially unchanged but efforts are made to further refine methods, optimise the scope of testing and increase the reliability of results. Projects are in progress to introduce risk-informed test object selection for example at the PWRs in Ringhals, where the in-service test programme is based on evaluation of failure probabilities and consequences using PSA methodology. Experience from similar development and applications abroad , e.g. in the Westinghouse Owners Group and NKS, are utilised. In another project the influence of human and organisational factors on testing is being studied.

Preventive maintenance

Maintenance of systems and structures including those important for safety is optimised with regard to the relation between corrective and preventive maintenance. The preventive maintenance of Swedish nuclear power plants includes predictive (condition-based), periodic and planned maintenance and serves to maintain the equipment within its design and operating conditions and to extend its life. A well- balanced preventive maintenance system is based on engineering analysis of both safety and economic factors and should minimise the risk for failures, which can limit safe and reliable operation or result in forced outages. Use of operational experience and insights from probabilistic safety analyses is important for the development of preventive maintenance and optimisation of the balance between maintenance measures and equipment modification or replacement. Introduction of new methodology along these lines, such as reliability centered maintenance (RCM), is discussed as a means to further improve and optimise the preventive maintenance.

Safety review

Different types of safety reviews are performed regularly at the nuclear power plants with the purpose of verifying that the operation is in accordance with applicable national safety requirements and with international guidelines and good practices. The primary safety reviews of events, plant modifications, changes in Technical Specifications (STF), etc., are carried out by the operations department, which is responsible for reactor safety. In addition important safety issues are reviewed a second time by the quality and safety department within the plant organisation, which is not involved in the preparation or execution of the issues under review. However, this second review is not supposed to be a repeat of the first one, but should be a judgement as to whether the issue has been treated in a satisfactory way from a safety point of view. Consequently the focus should be on the analyses that the conclusions are based upon and whether these have been performed with enough depth and sufficient professional quality.

The new SKI regulations SKIFS 1998:1 emphasise the requirement for a primary safety review by those handling a specific issue and a secondary one by an independent body as described above. The formal documentation of the safety reviews has become stricter and the organisation and resources for safety review have been strengthened. Generally, the resources for safety reviewing have been concentrated to the plant organisation, but off-site competence is utilised in cases where specialised expertise is needed. Another consequence of the new regulation is that the area of issues to be reviewed has been extended to contain e.g. organisational changes and operations procedure modifications.

Policy issues and other more fundamental safety matters are discussed and reviewed in the safety committees/councils on corporate and plant management levels. They are chaired by the nuclear chief executives at each level and comprise responsible operation and safety department managers. In some case external experts are members of the safety council/committee.

International peer reviews continue to be performed at the Swedish nuclear power plants. Since the first report to the Convention WANO peer reviews have been performed in Ringhals and Barsebäck giving

valuable recommendations for the improvement of safety. Since the Swedish membership in INPO was terminated, no further technical visits or other INPO reviews are anticipated.

14.3 Regulatory control

As mentioned earlier in the report, SKI has since the new general safety regulations came into force inspected the safety review organisations and procedures at all nuclear sites. The conclusions of SKI from these inspections were that requirements on documentation of the new procedures were not fully met. There was also some disagreement with the licensees about how to conduct the independent safety review in relation to the primary reviews. This issue is currently being addressed in joint discussions with 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. Evaluation of the designs against new knowledge, requirements and practices have, however, been done to a varied extent and SKI will make an extended review and assessment on this point.

The safety programmes required by each licensee according to SKIFS 1998:1 have been requested by SKI and were submitted by all plants in 2000. The review of these programmes by SKI is still in progress.

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 reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

15.1 Regulatory requirements

Since the first report to the Convention, a number of regulations have been modified. Today there are 46 regulations issued covering most areas where radiation may occur. Of these, the following are particularly applicable to the nuclear industry:

- 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)
- Regulations on categorisation of workers and working places in practices with ionising radiation (SSI FS 1998:3)
- Regulations on dose limits for ionising radiation (SSI FS 1998:4) (replaces SSI FS 1989:1)
- Regulations on monitoring and reporting of individual radiation doses (SSI FS 1998:5)
- Regulations on medical examinations for radiological activities (SSI FS 1998:6, replaces SSI FS 1981:3)
- General advice on the competence of radiation protection experts (SSI SF 2000:6)
- Regulations on radiation protection of workers exposed to ionising radiation at nuclear plants (SSI FS 2000:10) (replaces SSI FS 1994:2)
- Regulations on radiation protection manager at nuclear plants (SSI FS 2000:11) (replaces SSI FS 1994:1)
- Regulations on protection of human health and the environment at discharges of radioactive substances from some nuclear plants (SSI FS 2000:12) (enter into force on 1 January 2002 and will then replace SSI FS 1991:5)
- Regulations on the handling of radioactive waste and nuclear waste at nuclear plants (SSI FS 2001:1) (enters into force on 1 January 2002)

Some important changes in the above regulations are the following:

Paragraphs regarding on-site activities with optimisation of radiation protection have been expanded in some parts. ALARA-principles have to be expressed in actions and goals by the licensee and resources allocated for these actions shall be documented. There are also requirements on the licensee to follow up and evaluate the ALARA programme at least once a year. Detailed strategies are required regarding actions to avoid fuel failures or, if they occur, reduce the consequences of them. This is important with respect to workers protection as well as releases and waste handling.

The new regulations also state that every person-dosimeter laboratory (P-dl.), which delivers dosimeters to category A-workers has to be examined and approved regarding quality aspects and physical demands on the dosimeters in use. All the Swedish nuclear energy facilities have an on-site P-dl., these have been examined and approved during 2000. SSI will follow up of this control every two years of operation.

Another major change is the regulation on restriction of emissions of radioactive substances from nuclear facilities. In the new issue (SSI FS 2000:12) all major nuclear facilities are now included and dose-limits are presented in dose values instead of ”norm-releases”. The regulation will enter into force in 2002. A more detailed presentation of releases to the environment and the regulations behind them is presented in section 15.3 below.

15.2 Measures taken by the licence holders

The organisation of radiation protection at the nuclear power plants

Some changes have been made in the organisation of Radiation Protection (RP) resources at the nuclear power plants since the first report to the Convention. Some plants have moved towards a centralised organisation of the RP resources instead of having them decentralised at the different units. The number of RP technicians has been reduced and they have a clearer focus on RP issues and do not take on other service functions, which was often the case previously. The consequence of this is that the accountability for minor RP issues is to a higher degree left with the operations and maintenance groups and individuals. One condition for accepting this development has been an increasing awareness of RP issues among all personnel, which has been achieved through a focussed information and education campaign in this area. A corresponding centralisation of the maintenance staff has also been carried out, which is also an aid and simplification for the RP staff in their communication with the maintenance groups.

For Barsebäck, now with only one unit in operation, its own staff has been reduced and the RP-function relies partly on contractors even during normal operation.

Internal procedures for radiation protection

No fundamental changes have taken place within this area. At one of the Swedish plants a large number of specific RP-procedures dedicated to maintenance activities have been implemented into the corresponding

maintenance procedures. This has, together with a restructuring of the quality and management system, lead to a large reduction in RP-procedures, and a better overview and control of the RP-procedures.

Dose registration and system radioactivity control

As mentioned in section 15.1, SSI has formally approved the personnel dosimetry facilities at the four Swedish Nuclear power plants, where all TL-dosimeters used at the plants are evaluated.

As a complement to annual or biennial qualified measurements of activity build-up and dose-rates in various reactor systems, two of the Swedish reactor units, Barsebäck 2 and Ringhals 1, have installed an on-line activity measurement system 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.

Dose reduction and implementation of ALARA programmes

The work to identify the potential means for reducing the dose rates in the plants, and consequently also the collective radiation doses, is always an on-going task. As mentioned in the first report to the Convention, different areas have been investigated and several possibilities have been identified, sometimes specific for a given reactor. The following are examples of measures, which have been taken or initiated during the recent years. The efforts have already been fruitful with decreasing collective doses at most plants, in some case the lowest ever, in spite of long refuelling outages at some units.

- The zinc injection method has been introduced and been in operation in Barsebäck for two years. The method has proved to be efficient and might lead to a later implementation in the other plants. However, there are other measures which in some cases serve the same purpose, maybe at a lower cost, one of them being chemical decontamination of the primary systems, which is being used prior to comprehensive work in the primary systems, but also has documented long-lasting effects.

- The replacement of piping and valves in the reactor containment, which has been done or is planned at some plants in the near future, makes it possible to reduce doses. With improved material and longer inspection intervals, radiation doses to testers, who are often considered a critical category in this context, will be reduced. Replacement of valves to such without the cobalt-containing stellite will improve the situation further.

- Replacement of the RPV steam separators at Forsmark 1 and 2 has helped to reduce the moisture content in the steam to the turbine and thereby decreased the dose rates in the turbine systems.

- Decontamination of fuel elements is one other method which is planned to be used on two-year-old elements at Ringhals 1, to reduce radioactivity and dose rates in the primary system parts. Tests are currently being performed on spent fuel elements in order to verify that there are no negative effects from the method.

- Contributing to very low dose rates and doses at the Ringhals PWR units has been the optimisation of the water chemistry from the activity-build-up point of view. This process has been going on for several years in order to verify the positive effects on the materials. In this context the chemistry conditions during start-up and shutdown have been specifically investigated since these transients otherwise might lead to activity build-up.

- Organisational changes and a higher individual accountability for the radiation protection described above also serves the purpose of improving the efficiency of the RP-work and reducing the collective radiation doses at the plants.

All these measures are in accordance with the individual plant ALARA-programmes, which are reviewed and updated annually. When deciding on dose-reduction measures an alfa-value (cost/benefit value) of 4000 kSEK/manSv is considered.

Environmental radiological surveillance

As described in section 15.1, new stricter requirements from SSI concerning the measurement of tritium and C-14 in the release paths through the ventilation stacks will probably force the Swedish Nuclear power plants to install advanced specific equipment for such measurements, at a fairly high cost.

15.3 Environmental impact of the Swedish nuclear power plants

Workers protection

In 2000, the collective dose to nuclear power workers in Sweden was the lowest ever since all reactors were taken into operation. With an installed electrical capacity of 10 GW the numerical value was 8.1 manSv. The dose trend over ten years to the Swedish nuclear plant workers is shown in figure 6. Major reasons for the prevailing positive dose situation are decreasing or steady radiation levels in reactor systems in combination with well prepared operations. There is also a tendency in the recent years to spread large modernisation work over time. The average radiation doses to different categories of workers are also slightly decreasing over the recent years (see figure 7 and table 8).

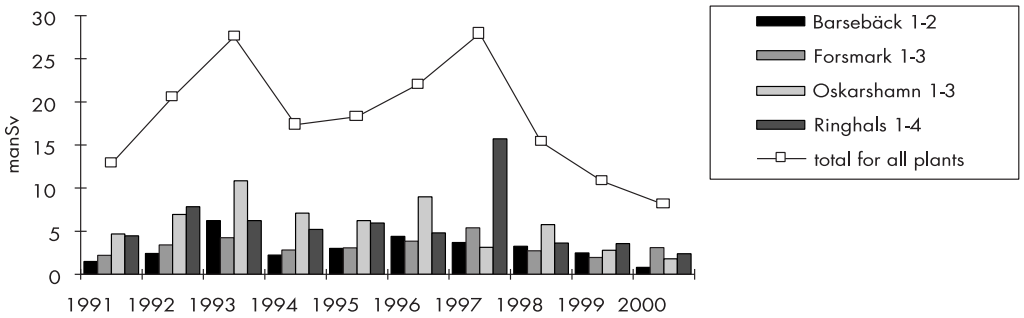

Figure 6. Collective doses at Swedish NPP's. Major modernisation work was performed in campaigns 1993 and 1997 as can be seen in the two peaks in the diagram.

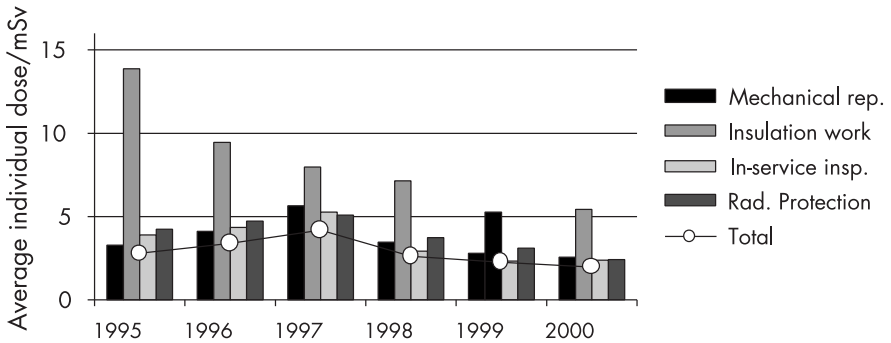

Figure 7. Average individual dose to some different categories of workers.

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

Table 8. Radiation dose statistics for nuclear power workers over the last years.

Releases to the environment

The release of radioactive substances to the environment was an issue in the Swedish report discussed at the last review meeting. In the written reply from Sweden to some questions, complementary information was given regarding regulations and tables were submitted showing discharge and emission values. It should be noted that the Swedish regulations, issued by SSI, focus on the calculated effective dose to individuals in the critical group and not on the directly measured releases of radionuclides. However, the measured nuclide specific activity released is used, together with mathematical models, to calculate the doses. All radioactive substances released to water and air are included in the calculation of the dose to the critical group. The reference value (limitation value) in the regulations for radiation dose to the critical group is 0.1 mSv per year for each nuclear site, independent of the number of reactors (release points).

Figure 8 below shows the radiation doses related to all releases for the year 2000 from nuclear power plants and other nuclear facilities. The values for C-14 are calculated based on the installed capacity. In figure 9 the trends are shown for the time period 1985-2000. The contribution to dose from C-14 is not included in figure 9, as this is principally a constant which does not influence the time trends. Generally, the resulting doses to individuals in the public are less than 1% of the limit, except for one site (Ringhals) where the resulting dose has been considerably higher during the nineties. The main reason for this is a combination of fuel leakages and the short delay of effluents (BWR). However, successive exchange of spent fuel and technical measures regarding withholding and delaying systems taken by the operator have reduced the releases from the site in the recent years as can be seen in figure 9.

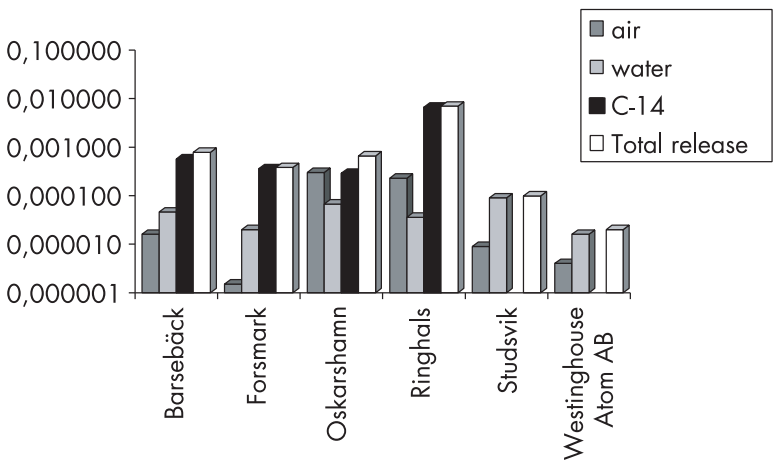

Figure 8. Radiation doses (in mSv) to individuals in critical group from releases in year 2000.

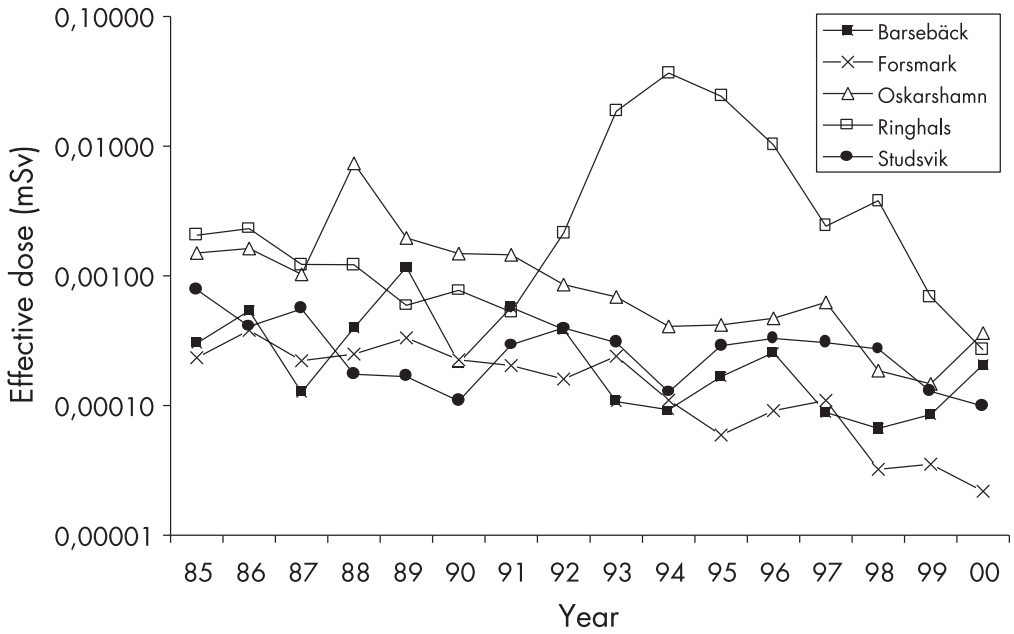

Figure 9. Radiation doses (mSv) to individuals in the critical group during 1985 to 2000. (Doses from C-14 are not included).

15.4 Regulatory control

See section 7.4.

15.5 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 installation, 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

The first report to the Convention includes an overview of the requirements concerning the on-site emergency preparedness, as well as the requirements concerning off-site planning for protection of the public. It is mentioned that several previous licensing conditions have been included in the new general safety regulations (SKIFS 1998:1). It is here required of the licensees, in the event of incidents, which can lead to a radiological accident, there are plans for:

- alerting the emergency preparedness personnel without delay,
- bringing the plant to a safe and stable state,
- informing about the technical situation at the plant.

The plan shall be kept up-to-date and tested in regular exercises. The basic plan shall be approved by SKI, and SKI shall be notified about principal changes, after a twofold safety review by the licensee.

It is further required that there are specially assigned and trained personnel, suitable emergency operating centres, technical systems, tools and protective equipment to the extent needed to carry out the mentioned tasks. Further details about planning conditions are given in the general recommendations to the regulations.

Apart from SKI, other authorities issue requirements on the licensees concerning emergency preparedness. SSI has issued requirements on radiation protection and monitoring (see chapter 15). The Swedish Rescue Services Agency has issued requirements regarding alarming and information of the public. No changes have been made in these requirements since the first report was issued.

16.2 Measures taken on-site and off-site

The first report to the Convention includes an extensive description about emergency plans and arrangements in the nuclear industry as a response to the requirements. The planning done by the regional county administrations to co-ordinate public protection measures as well as exercises are also described. No essential changes have been made during the last three years.

With regard to national monitoring and measuring, SSI has upgraded the software for the computerised logging of the gamma stations and the dissemination of measurement values, also including the possible exchange of values in the Baltic region. The new web-based system was taken into operation in February 2000.

An agreement has been reached with Lithuania on the continued use of an early warning system (satellite communication), in the event of an accident at the Ignalina Nuclear Power Plant.

16.3 Exercises

As mentioned in the first report to the Convention, every year a "total" exercise is performed in Sweden at one of the nuclear sites to check the plans and the capability of the on-site and off-site organisations. These exercises are planned by the respective county administration 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 three years, exercises have been conducted at Forsmark and Barsebäck, with international participation from Åland, Finland and Denmark . The evaluations showed good results.

An international three days measurement exercise has also been held in Sweden (Gävleborg County) during the reporting period. The objective was to test existing mobile systems for identification and measurement of radioactive ground contamination after a nuclear power accident. Comparisons were made between the measurement systems of all the states around the Baltic, except Germany. Possibilities were explored to co-operate in the event of accidents. All Swedish contracted measurement laboratories participated in this exercise.

In addition to the mentioned off-site exercises a number of more limited on-site exercises have been conducted at all the Swedish nuclear power plants.

16.4 New developments in Emergency Preparedness

In order to improve the capability to perform reliable and faster radiological emergency assessments, a co-operative R&D project between SKI and Barsebäck Kraft AB has been carried out during the last three years. The project focuses on the initial stage of an accident, from the initiating event up to the time of radioactive release. The result is a user-friendly tool called HAMPUS[13] (means for assessment and method

[13] Further information can be provided by SKI, attention the EP Co-ordinator (email: richard.olsson@ski.se).

for prognosticating of radioactive releases). This tool allows the emergency analysis group at the plant, and the analysis group of the regulator, to make estimates of releases based on a large amount of information from the plant process and its safety analyses, notably the PSA level 2. The release can be estimated as regards magnitude and time, through an iterative process that allows estimates of threat situations, an approaching release and a release, through monitored as well as non-monitored routes. The tool, which so far is only used in Barsebäck, is in a paper format, although there are plans to convert it into electronic format. The tool has been tested in emergency exercises with good results for the plant as well as for the regulator. The time needed for making release projections has been reduced considerably. This has in turn allowed the rescue manager more time to decide on adequate protective measures.

SKI is now working to implement this model on a national basis. However, this is not a requirement at present and discussions are under way with the licensees. A full implementation of the model will also make possible some changes in the tasks and working procedures of the SKI emergency organisation.

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.

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.

Apart from the R&D project mentioned above, SKI has 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. Recent exercises have shown that these efforts have been successful. SKI has also taken an initiative in creating a national network for emergency preparedness also for the support of further research and development efforts.

16.5 Regulatory control

As described in the first report to the Convention, SKI has continued together with SSI to inspect the emergency planning of the licensees. In addition, SSI has made own inspections of the capabilities of the licensees to ensure the radiation protection of their staff in accidents with high radiation levels. The procedures for alarming and to provide continued information about the technical- and radiation protection status have also been assessed. Some specific internal procedures need more attention, but in general the regulatory bodies are satisfied with the measures implemented at the nuclear power plants.

16.6 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 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 National situation

In the first report to the Convention, the considerations and practices used in the original siting of the Swedish Nuclear power plants are described and also the requirements and practices applied since then in site re-evaluations. Nothing has changed regarding this issue since 1998. According to a governmental decision, which is also codified in § 5 the Act on Nuclear Activities, no new nuclear power plants are allowed to be sited in Sweden. Decommissioning plans will include complete restoration of the sites.

17.2 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

The new general safety regulations (SKIFS 1998:1) include with a reference to the Act on Nuclear Activities the following fundamental provision:

”Nuclear accidents shall be prevented through a basic facility-specific design which shall incorporate multiple barriers as well as a facility specific defence-in-depth system” (Chapter 2, § 1). The general principles behind achieving defence-in-depth are further specified. In the general recommendations to this paragraph a reference is given to the IAEA report INSAG-10 regarding further definitions of defence-in-depth. This means that five levels are applied in Sweden.

All the provisions of the general safety regulations can be regarded as a further specification of what is required in order to establish, maintain, further develop, verify and regulate the integrity of the barriers and a good quality defence-in-depth system in major nuclear installations. This safety concept, although not including severe accidents, has been applied in Sweden as a major licensing condition since the US 10 CFR 50 Appendix A, General Design Criteria were issued in 1971. However, since the general safety regulations came into force, the safety concept of multiple barriers and defence-in-depth has been actively used to structure the conclusions from the safety assessments of the plants.

More specified requirements on design and construction, in order to achieve what is required in the above mentioned basic paragraph, are given in chapter 3 of the general safety regulations. These can be summarised in the following points.

The design shall

- be able to withstand component and system failures,
- be reliable and have operational stability,

- be able to withstand such events and conditions which can affect the safety function of the barriers or defence-in-depth, as well as

- be maintainable, controllable and testable.

It is further required that design principles and design solutions shall be tested under realistic conditions, or if this is not possible or reasonable, have undergone the necessary testing or evaluation with reference to safety. Design solutions shall be adapted to the ability of the personnel to manage the facility in a safe manner as well as to manage abnormal events, incidents and accidents. Functional based safety classification is also required. In the general recommendations to these legally binding requirements, guidance is given on their interpretation and application.

The general safety regulations do not contain any specific requirements on severe accident mitigation. As mentioned in the first report to the Convention, requirements on release mitigation in the event of severe accidents were given in a government decision in February 1986[14], as a condition for operation after 31 December 1988. This decision states that, in the event of an accident involving severe core damage including core melt, releases should be limited to a maximum of 0.1% of the core content of cesium 134 and cesium 137 for a reactor core having a thermal power of 1800 MW. This is on condition that corresponding fractions of other nuclides that have a significant role in ground contamination also are retained. Severe accident sequences with extremely low probability, such as pressure vessel rupture, need not be taken into account. It should be noted in this context that the total radioactive fallout over Sweden after the Chernobyl accident corresponds to more than 1% of the core content of cesium in the Chernobyl reactor. During the 1980's, these release mitigation requirements led to major back-fitting of the Swedish reactors, such as filtered containment venting systems and diversified containment cooling[15]. Plant-specific accident management procedures were also required in the governmental decision and introduced in the end of the eighties. The objective of these procedures is to enhance the capability of bringing a severe accident sequence under control and achieving a stable final state, with a damaged core covered by water and cooled, with the containment depressurised and with integrity preserved.

Requirements concerning protection from intentional damage such as sabotage are posed in special directives as licensing conditions. A new regulation is in preparation to replace these directives from the seventies.

As mentioned several times earlier in this report, SKI has decided to extend the general recommendations to SKIFS 1998:1 regarding design and construction of nuclear power reactors. A draft has been developed and is under discussion with the licensees. The objective is to issue back-fitting guidelines valid for the rest of

[14] Swedish Government Decree, February, 1986 (in Swedish).
[15] Release-Limiting Measures for Severe Accidents. Swedish Nuclear Power Inspectorate - Swedish Radiation Protection Institute Report to Government, December, 1985 (in Swedish).

the operating time of the Swedish reactors. In addition to the general SKI mission, given by the Government, to clarify the requirements, there are two major reasons for this decision:

- operational experience and other experience gained from safety analysis and research show that a more precise interpretation of certain existing requirements in SKIFS 1998:1 is justified,

- the utilities have requested, a clarification of the future requirements in Sweden, as a basis for major investment decisions.

The planned guidelines are an interpretation of the safety objectives to be reached as a result of taking into account current experience and the general requirements on maintaining and developing safety. The general recommendation format allows a flexible interpretation for each reactor, taking into account their different designs and conditions from a risk-informed perspective. Final requirements on upgrading measures and time schedules will be posed as licensing conditions. The end result should be an essential compliance of all Swedish reactors with modern safety requirements and practices.

Some issues to be addressed in the new guidelines are:

- **severe accidents**: increased possibilities to feed water in the reactor pressure vessel during accident conditions, increased application of the fail-safe principle, extended definition of end states after different events,

- **withstanding of failures**: more focus on diversification of safety systems, more clear demands on analysis of internal and external events, more clear demands on fire event classification, more clear demands regarding pipe breaks and local dynamic effects of pipe breaks,

- **environmental qualification**: specific references are given,

- **operator conditions**: specification of work conditions and information needs,

- **safety classification**: more precise demands,

- **safety verification**: application of risk-informed knowledge,

- **operability verification**: more precise conditions,

- **reserve control room**: design prerequisites.

The project to define the new guidelines will be conducted in co-operation with the utilities and the results of the utility project to define future requirements will be used. The new guidelines are planned to be issued during 2002 after proper consultation with a number of organisations. A consequence

assessment supporting the guidelines is needed, according to Swedish legal procedures, before the final decision can be taken.

18.2 Measures taken by the licence holders

Defence in depth

The safety philosophy applied in the design of all Swedish nuclear power plants is based on the principles of defence in depth and of multiple barriers to prevent the release of radioactive material to the environment. They were all designed to fulfil the intention of the requirements of the General Design Criteria and analyses are provided in the FSAR of each unit to show how this is accomplished. Various back-fitting measures have been introduced since the plants were taken into operation, the most comprehensive of which is the severe accident mitigation programme completed in 1988, comprising diversified cooling and filtered venting of the containment. The foundation of the safety principle on the defence in depth is emphasised and made clearer through the implementation of the principle in the SKI regulations SKIFS 1998:1.

In the last few years, the discussion concerning safety requirements for the future operation of the Swedish nuclear reactors has been lively within the utilities as well as SKI. A co-operation project with participation from all the plants was initiated with the aim to investigate and propose criteria and safety measures to achieve an adequate future safety level. Although this work has not resulted in a common criteria document for the utilities, a comprehensive technical material has been compiled which serves as a basis for the dialogue with SKI concerning the planned back-fitting guidelines mentioned in section 18.1.

Although the deterministic safety criteria and analysis is the licensing basis, PSA methodology is being used to an increasing extent, as a complementary basis in the modernisation work. In combination with the upgrading of the Ringhals 1 primary system by replacing corrosion-sensitive material, the leak-before-break concept is proposed for use to relax deterministic requirements on e.g. pipe-break restraints. There are other similar examples of risk-informed design in Swedish Nuclear power plants where probabilistic analyses are used in the design basis for a specific modernisation or replacement item.

Forsmarks Kraftgrupp AB is a member of the EUR (European Utility Requirements) group as representative for the Swedish utilities. Experts from Forsmark and the other Swedish nuclear plants have participated actively in the development of requirement documentation for several BWR plant concepts such as the Westinghouse Atom design BWR 90+, General Electric design ABWR, and the Siemens design SWR1000. These EUR Volume 3 documents are or will be completed in the near future. The co-operation in the EUR project is planned to continue for several more years and the planning of the strategy and activities for future work is presently going on. The overall objective for the Swedish participation is unchanged viz. to obtain a basis for further development of the safety of the existing plants in Sweden.

Proven technology

The principle of proven technology is broadly accepted and implemented in the design and construction procedures for the Swedish nuclear plants. In the current modernisation programmes, the use of up-to-date but proven technology is also one of the basic criteria.

The functioning of safety-related systems and components during emergency conditions is ensured by using proper environmentally qualified equipment. A comprehensive programme for environmental qualification has been carried out. No major new steps are envisaged in addition to the previous programme, although further research and development is continuing. In the modernisation work, the specification of all new instalments is carefully checked with respect to environmental requirements.

Reliable, stable and easily manageable operation

The Swedish nuclear plants were all designed with the goal of high inherent stability and few operational disturbances. The control rooms were designed based on experience and design rules within each owner organisation. In the completed and on-going modernisation projects including control room up-grading, MTO (human factors) and the man-machine interface have been given considerable attention and the experience from earlier operation has been an important input.

Measures to improve physical and functional separation

The separation of systems, physically and functionally, is an important area in which a number of back-fitting measures have been implemented over many years as previously reported. In many cases, the need for improved separation was identified in PSA analyses. This work continues in ongoing modernisation projects in which, for instance, improved separation is one of the objectives of the Ringhals 2 project for modernisation of the electrical equipment and I & C systems (TWICE project). Further work to improve separation and diversification in all reactors is planned as part of the safety programme to meet the new back-fitting guidelines mentioned above.

Measures to further improve the capacity to mitigate severe accidents

As reported in the first national report, a comprehensive programme for introducing mitigation measures with respect to severe accidents was implemented during the eighties. Since then, international research and development has been followed by the Swedish utilities and SKI in collaboration and the experience and new knowledge gained has been adapted for the Swedish situation and implemented when appropriate. From the work carried out over the last three years, the following topics can be noted: hydrogen analysers, optimisation of accident management with respect to release to the environment and the introduction of a severe accident management guide for PWR.

Changes of I&C and new control room concepts

The technical development in the I&C area is very fast and fundamental and much of the equipment from the construction phase of the Swedish nuclear plants is becoming obsolete. Several programmes of various extent for modernisation of I&C systems and control rooms have, therefore, been carried out in most plants during the last few years and are envisaged to continue. Somewhat different approaches have been taken in the I&C modernisation work by the different plants, in particular with respect to the introduction of digital technology.

At Ringhals, the TWICE project, mentioned earlier, so far comprises design and analysis work but has entered the implementation phase in 2001. Up to 2004, TWICE comprises replacement of non-safety related I&C systems in the auxiliary building, the unit computer and the turbine and reactor systems (including control room equipment).

At Forsmark, comprehensive renewal of I&C-systems, both on the reactor and turbine side, has been made for the units 1 and 2. A new control system hard-ware basis has been introduced and frequent use is made of displays in the operator interface. Among the systems replaced by new equipment for improved performance and reliability are the control rod manoeuvering as well as display, and turbine control. In Forsmark, a restrictive position has been taken with respect to the use of digital technology in the I&C-systems and analogue equipment is preferred, when possible.

In Oskarshamn new digital I&C-equipment has been introduced, including in the reactor protection system (RPS). Manoeuvering of control rods is made through displays and hard-ware buttons at the so called safety desk. A hard-wired back- up is available for the RPS in case of RPS computer failure.

Operating experiences related to design

For BWRs, the problem of core instability has to be considered and in some of the Swedish BWR plants, core power oscillations have been experienced on a number of occasions. As described in the first national report, several measures have been taken to secure stability in the operational region, detect deviations from stable behaviour and suppress induced power oscillations. By these measures, induced instabilities are detected and readily managed without threatening nuclear safety. The basic instability causes, which are to be found in the use of modern fuel designs, have, however, not been eliminated and a few instability incidents have occurred also during the last few years. In all these cases, the power oscillations have been limited/terminated by automatic actions. Further analyses have been carried out and complementary instrumentation been introduced at some plants but the recent experience has indicated that the dynamic behaviour of the core is not yet fully understood. Development work is going on to improve the in-depth understanding of the core instability problem and avoid unstable behaviour as a consequence of loading the new fuel designs.

18.3 Regulatory control

See section 8.4 about the SKI handling of notification of plant modifications according to the new safety regulations (SKIFS 1998:1).

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 new general safety regulations (SKIFS 1998:1) contain legally binding requirements relevant for all obligations of Article 19. These requirements are summarised below.

Initial authorisation

As mentioned in section 14.1, a preliminary comprehensive safety report is required before construction and a final full safety analysis report, also taking into account the results from commissioning tests, is required before taking the facility into operation (Chapter 4, §§ 1 and 2).

Operational limits and conditions

Documented up-to-date Technical Specifications are required containing the necessary operational limits and conditions, as further specified in a separate annex to the regulations. The Technical Specifications shall together with the operational procedures ensure that the conditions which are postulated in the safety report are maintained during the operation of the facility (Chapter 5, § 1). The Technical Specifications shall be subjected to a twofold safety review by the licensee and submitted to SKI for approval. SKI shall be notified about any changes after a twofold safety review by the licensee.

Approved procedures

Suitable, verified and documented procedures are required for all operational states including accidents. The procedures for operability verification and procedures used in other operational states than normal operation shall be subjected to a twofold safety review by the licensee. A full scale simulator should be used if possible and to suitable extent for verification of operational procedures. Procedures for maintenance which is important to safety are also included in the requirement. Maintenance programmes shall be documented. Inspection and testing of mechanical components shall be carried out according to qualified methods and verified procedures (Chapter 5, § 2 and 3, and SKIFS 2000:2).

Engineering and technical support

The licensee shall ensure that adequate personnel is available with the necessary competence and suitability needed for those tasks which are important for safety, and also ensure that this is documented. A long term staffing plan is required (Chapter 2, § 3 point 4). The use of contractors as opposed to own personnel should be carefully considered in order to develop and maintain adequate in-house competence. The necessary competence should always exist in-house for ordering, managing and evaluating the result of work important for safety which is carried out by contractors.

Reporting of incidents in a timely manner

SKIFS 1998:1 contains a whole chapter about reporting requirements and an annex specifying these requirements for various types of events (chapter 7 and annex 4). The following is a brief summary:

- Reporting without delay: emergency alarm events and events and conditions in category 1 (see below)
- Reporting within 16 hours: INES events at level 2 or higher
- Reporting within 7 days: a comprehensive investigation report about alarm events or events and conditions in category 1
- Reporting within 30 days: a comprehensive investigation report of events and conditions in category 2

In addition, there are requirements on daily reporting of the operational state, power level and the occurrence of any abnormal events or disturbances, such as scram, and requirements on a comprehensive annual report summarising all experience important for the safety of the plant. Specifications are given about the contents of the different reports and further interpretation of the reporting requirements is given in the general recommendations.

In one of the basic paragraphs of SKIFS 1998:1, requirements are given on actions to be taken by the licensee in cases of deficiencies in barriers or in the defence-in depth system. These actions include first assessment, adjustment of the operational state, implementation of necessary measures, performing safety review and reporting to SKI. A graded approach is allowed here. In appendix 1 of the regulations, events and conditions are specified which require different responses, depending on the category of events they belong to. Three categories are defined in this annex:

Category 1

Severe deficiency observed in one or more barriers or in the defence-in-depth system, as well as a founded suspicion that safety is severely threatened. (In these cases the facility must be brought to a safe state without delay).

Category 2

Deficiency observed in one barrier or in the defence-in-depth system, which is less severe than that which is referred to in category 1, as well as a founded suspicion that safety is threatened. (In these cases the facility is allowed to continue operation under certain limitations and controls).

Category 3

Temporary deficiency in the defence-in-depth system which arises when such an event or condition is corrected and which, without measures could lead to a more severe condition, and which is documented in the Technical Specifications. (In these cases the facility is allowed to continue operation under necessary limitations during the implementation of the corrective measures).

In all three cases, corrective measures shall be subjected to a twofold safety review by the licensee. The results of these reviews shall be submitted to SKI.

Regarding category 3 events, there is no requirement to make a specific report to SKI. It is sufficient to make a compilation of these events in the annual report.

Programmes to collect and analyse operating experience

The licensee shall ensure that experience from the facility´s own and from similar activities in other relevant facilities is continuously analysed, used and communicated to the personnel concerned (Chapter 2, § 3 point 7). It is further required that all events and conditions which are detected and which are important to safety are investigated in a systematic manner, in order to determine sequences and causes, as well as to establish the measures needed in order to restore the safety margins and to prevent recurrence. The results of the investigations shall be disseminated within the organisation and shall contribute to the development of safety at the facility (Chapter 5, § 6).

Generation of radioactive waste

As mentioned in the first report to the Convention, there is no legally binding requirement in Sweden to minimise radioactive waste apart from requirements which follow from the ALARA principle (see section 15.1). The Swedish position is that such requirements could be detrimental to safety, for instance through higher burn-up of the fuel. Since disposal of spent fuel and nuclear waste is very expensive, the licensees have a powerful economical incentive to keep the volumes, as well as the activity, low.

The general safety regulations (Chapter 6, § 1-3) include provisions about:

- An up-to-date inventory register over all spent fuel and radioactive waste on-site.

- Measures for the safe on-site handling, storage or final disposal of waste shall be analysed and included in the safety report of the facility. The measures for on-site handling shall consider the requirements on safety posed by the continued handling, transport and final disposal of the waste. The safety report shall also include measures, which need to be taken on-site to prepare for the safe transportation, storage or final disposal in a nuclear waste facility.

- If such waste is generated that does not conform to the specifications in the safety report, measures for the safe handling of this abnormal waste shall be documented and SKI notified before any measures are taken. The documentation is subject to a twofold safety review by the licensee before notification.

Only packages approved by SKI and SSI may be transported to a final repository. For this approval, the waste must comply with the conditions stated in the safety report of the repository. For packages of waste ordinarily produced by the nuclear power plant, a type certificate can be issued by the regulatory bodies. Such approved type certificates will be included in the safety report of the waste producing plant, as well as in the safety report of the final repository.

19.2 Measures taken by the licence holders

The first report to the Convention includes a comprehensive description of actions taken by the licensees in relation to the requirements existing three years ago. In connection with coming into force of the general safety regulations on 1 July 1999, these measures were reviewed and adjusted in some cases in order to comply with the new regulations. The following is a brief summary of this development.

Operational limits and conditions

The Technical Specifications (STF) of the plants have been adjusted to the terminology of the new safety regulations and the partly new requirements to take graded actions in the event of deficiencies in barriers and the defence-in-depth system. The new reporting requirements have also been inserted. Modifications have also been made as a result of the design basis reconstitution projects.

The new SARs have to some extent changed the basis for the Technical Specifications. For some reactor units, this modification is more or less completed, while other units are still at an early stage. The overall structure of the STF has been retained and there is an ambition to use the same headlines in the SAR and the STF and thereby show the connection between the two documents.

There is also a development among the Swedish Nuclear power plants that the STF is being integrated into the plant quality and management systems.

The STF of the Westinghouse PWRs in Ringhals are being 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. The US requirements on Technical Specifications, 10CFR50.36, also satisfy the Swedish requirements in SKIFS 1998:1.

Approved procedures

No major changes have been made in relation to the earlier reporting. Computerised instruction systems are being studied as part of the modernisation of the control rooms (see section 6.3).

Response to anticipated operational occurrences and accidents

Procedures have been adapted to and revised in accordance with the new safety regulations (see section 19.1).

Engineering and technical support

The consequences, of the staff reductions of the Swedish nuclear power plants, mentioned in chapter 4 and section 11.4, and reduced general use of consultants, are monitored closely regarding the ability to deal in-house with certain safety issues. As mentioned, the modified investment plans have released important engineering resources for other important tasks, but in some specific cases the plants are becoming more dependent on consultants and expertise from outside the plant organisation. This is the case primarily for areas listed in the previous report, but to this could be added expertise and resources for software for safety applications and also process control and measurement techniques. In particular the IT-functions have been outsourced, but are still available on-site. Vattenfall and Sydkraft follow the demand and supply situation for qualified engineers in annual surveys which are monitored by the safety advisory committees.

Incident reporting

The system described in the first report has been adapted to the reporting requirements of SKIFS 1998:1 (see section 19.1). This means for instance that a preliminary event report concerning category 2 events is no longer required within 6 days. A final report is required within 30 days that includes higher demands on the investigation and with the conclusions of the safety reviews. Minor modifications have been made to the reporting form.

Operating experience analysis and feedback

The first report to the Convention included an extensive description of the industry system for analysis of domestic and international operational experience, and reporting in Sweden and internationally. This description is still valid, with the exception that the Swedish utilities have terminated their membership in INPO.

Generation of radioactive waste

The measures described in the first report on the handling of spent fuel, intermediate and low level waste at the nuclear power plants have not been changed.

19.3 Regulatory control

Basically the same procedures still apply as described in the first report to the Convention. Regarding the reviewing of incident reporting, a minor change has been made in the SKI procedure. 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. This change has been made in order to improve efficiency. The procedure for safety related event- and experience feedback analysis is now documented in the SKI internal quality management system (SKIQ).

The new reporting requirements in SKIFS 1998:1 have reduced the flow of licensee event reports (LER) from typically 30-40 per unit and year to 20-30 per unit and year. In about five cases per year, SKI requires further measures to be taken by the licensee as a result of assessing the report.

19.4 Conclusion

The Swedish Party complies with the obligations of Article 19.