Ds 2014:32

Sweden's fifth national report under the

Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management

Sweden's implementation of the obligations of the Joint Convention

REGERINGSKANSLIET

Ministry of the Environment
Sweden

Ds 2014:32

Sweden's fifth national report under the Joint Convention on the safety of spent fuel management and the safety of radioactive waste management

Sweden's implementation of the obligations of the Joint Convention

REGERINGSKANSLIET

Ministry of the Environment
Sweden

Swedish Government Official Reports (SOU) and the Ministry Publications Series (Ds) may be purchased from Fritzes Customer Service.

Ordering address: Fritzes Customer Service, SE-106 47 Stockholm, Sweden.
Telephone orders: +46 8-598 191 90
E-mail: order.fritzes@nj.se
Website: fritzes.se

As far as concerns distribution of SOU and Ds publications as part of a referral procedure, Fritzes Offentliga Publikationer has a remit from the Swedish Government Offices' Office for Administrative Affairs.

Cover: Government Offices standard.

Printed by: Arkitektkopia, Stockholm 2014.

ISBN 978-91-38-24168-4
ISSN 0284-6012

Contents

Contents **3**

List of Figures **5**

List of Tables **6**

Foreword **7**

SECTION A - Introduction **9**

A.1 Purpose and structure of this report 9

A.2 Summary of results from the previous review 10

A.3 Summary of developments since the previous report 12

A.4 Development of a national policy for spent fuel and radioactive waste management 16

A.5 Current legislative and regulatory framework 19

A.6 The management system for spent nuclear fuel and radioactive waste 28

A.7 Swedish participation in international activities to enhance safety and radiation protection 41

A.8 The European spallation source research facility 48

SECTION B - Policies and Practices **49**

B.1 Article 32.1: REPORTING 49

Section C - Scope of Application **55**

C.1 Article 3: SCOPE OF APPLICATION 55

Section D - Inventories and Lists **57**

D.1 Article 32.2: REPORTING 57

Section E - Legislative and regulatory system **73**

E.1 Article 18: IMPLEMENTING MEASURES 75

E.2 Article 19: LEGISLATIVE AND REGULATORY FRAMEWORK 75

E.3 Article 20: REGULATORY BODY 107

Section F - Other General Safety Provisions **121**

F.1 Article 21: RESPONSIBILITY OF THE LICENCE HOLDER 121

F.2 Article 22: HUMAN AND FINANCIAL RESOURCES 123

F.3 Article 23: QUALITY ASSURANCE 126

F.4 Article 24: OPERATIONAL RADIATION PROTECTION 130

F.5 Article 25: EMERGENCY PREPAREDNESS 139

F.6 Article 26: DECOMMISSIONING 152

Section G - Safety of Spent Fuel Management **159**

G.1 Article 4: GENERAL SAFETY REQUIREMENTS 159

G.2 Article 5: EXISTING FACILITIES 166

G.3 Article 6: SITING OF PROPOSED FACILITIES 167

G.4 Article 7: DESIGN AND CONSTRUCTION OF FACILITIES 175

G.5 Article 8: ASSESSMENT OF SAFETY OF FACILITIES 183
G.6 Article 9: OPERATION OF FACILITIES 194
G.7 Article 10: DISPOSAL OF SPENT FUEL 202
Section H - Safety of Radioactive Waste Management 203
H.1 Article 11: GENERAL SAFETY REQUIREMENTS 203
H.2 Article 12: EXISTING FACILITIES AND PAST PRACTICES 209
H.3 Article 13: SITING OF PROPOSED FACILITIES 211
H.4 Article 14: DESIGN AND CONSTRUCTION OF FACILITIES 213
H.5 Article 15: ASSESSMENT OF SAFETY OF FACILITIES 218
H.6 Article 16: OPERATION OF FACILITIES 221
H.7 Article 17: INSTITUTIONAL MEASURES AFTER CLOSURE 226
Section I - Transboundary Movement 229
I.1 Article 27: TRANSBOUNDARY MOVEMENT 229
Section J - Disused Sealed Sources 231
J.1 Article 28: DISUSED SEALED SOURCES 231
Section K – General Efforts to Improve Safety 235
K.1 Measures taken to address suggestions and challenges at previous review 235
K.2 Strong features, areas for improvement and major challenges identified by the Contracting Party 237
K.3 Implementation of Directive 2011/70/Euratom 244
K.4 National plan for the management of spent nuclear fuel and radioactive waste 244
K.5 Plutonium transfers 245
K.6 Policy and plans for international peer review missions 246
K.7 Periodic Safety Reviews 247
K.8 Actions to enhance openness and transparency in the implementation of the obligations under the Convention 248
List of abbreviations 249

List of Figures

Figure A1: Nuclear facilities in Sweden. 17
Figure A2: Licensee basic requirements and general obligations. 20
Figure A3: The step-wise process of regulatory authorisation and supervision following a Swedish Government decision licensing a nuclear facility. 21
Figure A4: Management system for spent nuclear fuel and radioactive waste as presented in RD&D programme 2013. 29
Figure A5: M/S Sigrid, the new transport ship for spent nuclear fuel and radioactive waste. 30
Figure A6: Storage pool in Clab. 31
Figure A7: Photo from the top of the silo in SFR. 32
Figure A8: The underground parts of the Äspö Hard Rock Laboratory. 33
Figure A9: Friction stir welding at the Canister Laboratory. 34
Figure A10: The Bentonite Laboratory at Äspö. 35
Figure A11: The reference method KBS-3 for disposal of spent nuclear fuel. 36
Figure A12: Main timetable for SKB's nuclear waste programme... 38
Figure A13: Extended SFR. The existing part is light grey and the planned part is blue. 40
Figure D1: Reactor top and pools at one of the Swedish reactors. 59
Figure D2: The Clab facility. 61
Figure D3: The facilities at Studsvik. 64
Figure D4: The FSR facility. 66
Figure D5: Radionuclide specific activity content in SFR. The numbers are for the situation as at 31 December 2012. 69
Figure D6: Principle section of shallow land burial at OKG. 70
Figure D7: The shallow land burial at OKG. 71
Figure E1: Overview of the Swedish legislative system. 77
Figure E2: Licensing procedure for nuclear facilities... 99
Figure E3: The present organisation of SSM. 110
Figure E4: The SSM management system process scheme. 115
Figure F1: SKB's Management System. 128
Figure F2: Average doses (mSv) to the personnel at Clab 2007-2013. 136
Figure F3: Effective dose (μSv) to representative person in the critical group... 137
Figure F4: Effective dose to representative person in critical group. 137
Figure F5: Current alarm sequence for an emergency event at a Swedish nuclear facility. 143
Figure F6: National expert response organisation for nuclear and radiological emergencies. 144
Figure G1: The stepwise procedure for the siting of a spent fuel repository. 171
Figure G2: The procedure for the licensing of SKB's licence application for a spent nuclear fuel repository and an encapsulation plant. 190
Figure G3: Schedule for SSM's licensing review. 191
Figure H1: Reference design of dome-shaped plug for a deposition tunnel. The concrete dome is made of unreinforced low-pH concrete. 215
Figure H2: Reference design for closure of SFR including extended part with detailed view of silo... 216

List of Tables

Table A1:	Joint Convention Reporting Provisions.	9
Table A2:	Revised overview of the Swedish programme for management and disposal of spent nuclear fuel and radioactive waste.	12
Table A3:	Facts about M/S Sigrid.	30
Table B1:	Waste classification scheme used by the nuclear industry in Sweden.	52
Table B2:	Comparison between the Swedish classification scheme and IAEA definition.	52
Table D1:	Inventory of spent fuel in NPP pools.	58
Table D2:	Spent fuel from the research reactor R1 temporarily stored in Studsvik.	59
Table D3:	Inventory of spent fuel stored in Clab as at 31 Dec. 2013.	60
Table D4:	Waste treatment methods at the NPPs (no more operational waste is currently produced at the Barsebäck site after the closure of the plant).	62
Table D5:	Inventory of disposed radioactive waste in AM as at 31 Dec. 2013.	65
Table D6:	Principle data for SFR.	68
Table D7:	Inventories of disposed radioactive waste in SFR as at 31 Dec. 2012.	69
Table D8:	Inventories of waste disposed of in shallow land burials.	71
Table E1:	Educational background of SSM staff.	113
Table E2:	Budget of SSM in million SEK (1 SEK is about 0.1 Euro).	116

Foreword

The areas covered by the Joint Convention have for a long time now been incorporated in the Swedish system for spent fuel and radioactive waste management. The Swedish Government judged at the time of signing the Joint Convention in 1997 that the safety philosophy, legislation and the safety work conducted by the licensees and the authorities in Sweden complied with the obligations of the Convention.

The current report reflects a transition to a licensing phase in the Swedish programme for management of spent nuclear fuel. The licensing review of the nuclear industry's licence application for a spent nuclear fuel repository and an encapsulation plant is progressing and a review statement by the Swedish regulator, with a recommendation for a government decision, is expected in 2016. In 2014, Sweden also expects to see a licence application for an extension of the existing repository for low and intermediate level waste (the SFR facility) to receive decommissioning waste.

This report has been produced by a working group with representatives from the Swedish Radiation Safety Authority (SSM) and the Swedish Nuclear Fuel and Waste Management Company (SKB). Other organisations of the nuclear industry have been consulted and provided information. The report constitutes an updated document with basically the same structure as the previous national reports under the Joint Convention, although section A (Introduction) and section K (General efforts to improve safety) have been revised in response to the updated guidelines agreed on at the Extraordinary Meeting held in May 2014.

A.1 Purpose and structure of this report

Sweden signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) on September 29, 1997. Sweden ratified the Joint Convention about two years later and has been a Contracting Party to the Joint Convention since July 29, 1999. The Joint Convention entered into force on June 18, 2001.

Each member nation having ratified the Joint Convention (Contracting Party) is obligated to prepare a National Report covering the scope of the Joint Convention and to subject it to review by other Contracting Parties at Review Meetings held in Vienna, Austria. Sweden participated in the First Review Meeting in November 2003, the Second Review Meeting in May 2006, the Third Review Meeting in May 2009 and the Fourth Review Meeting in May 2012. This report is the fifth Swedish National Report under the Joint Convention.

This report satisfies the requirements of the Joint Convention for reporting on the status of safety at spent fuel and radioactive waste management facilities within the borders of Sweden. It constitutes an updated document with basically the same structure as the previous national reports under the terms of the Joint Convention and reflects developments in Sweden through December 2013. It will be subject to review in May 2015 at the Fifth Review Meeting of the Contracting Parties in Vienna.

The report's format and content follow the revised guidelines for structure and content of the report, as agreed at the Second Review Meeting of Contracting Parties to the Joint Convention in May 2005 (most of the revisions of the guidelines agreed on at the Extraordinary Meeting held in May 2014 have also been honoured). The sections in this report have the same titles as in these guidelines, thus facilitating review by other Contracting Parties. Table A1 provides a cross-reference between the sections in this report and the specific reporting provisions in the Joint Convention.

National Report Section		Joint Convention Section
A.	Introduction	
B.	Policies and Practices	Article 32, Paragraph 1
C.	Scope of Application	Article 3
D.	Inventories and Lists	Article 32, Paragraph 2
E.	Legislative and Regulatory Systems	Articles 18-20
F.	General Safety Provisions	Articles 4-9, 11-16 and 21-26
G.	Safety of Spent Fuel Management	Articles 4-10
H.	Safety of Radioactive Waste Management	Articles 11-17
I.	Transboundary Movement	Article 27
J.	Disused Sealed Sources	Article 28
K.	General Measures to Improve Safety	Multiple Articles
L.	Annexes	Multiple Articles

Table A1: Joint Convention Reporting Provisions.

Section A provides a broad overview of the Swedish waste management system including a brief account of developments since the last national report. Section A

also includes a summary of highlights and issues raised about Sweden during the fourth review meeting held May 14-23, 2012 and a list of issues Sweden was asked to report on in the fifth national report. Section K–in addition to summarising measures to improve safety–now contains the following new elements:

- measures taken to address suggestions and challenges at the previous review,
- a discussion of strong features, areas for improvement and major challenges in the Swedish programme for management of spent nuclear fuel and radioactive waste,
- policy and plans for international peer review missions, and actions to enhance openness and transparency in the implementation of the obligations under the Convention.

The programme for development and licensing of a geological repository for spent nuclear fuel is described in section G, whereas repositories for radioactive waste are described in section H.

A.2 Summary of results from the previous review

During the period before the fourth review meeting, Sweden received in total 133 questions on the report from 23 countries. The questions touched upon several articles of the Joint Convention and were mostly requests for clarifications, additional information and reports on experiences with specific practices. All the questions were answered on the Joint Convention website and commented on in a general sense at the review meeting.

During the discussion at the review meeting, it was agreed that Sweden seems to comply well with the obligations of the Joint Convention. It was concluded that a comprehensive regulatory framework is in place focusing on targets rather than on prescriptive requirements. Sweden has made good progress in realisation of repository projects and the existing policy of transparency and openness has contributed to a high level of acceptance among the public with regard to these projects. Another conclusion was that the financing system for decommissioning and disposal is designed to provide adequate funding for the implementation of the Swedish waste management concept.

The meeting emphasized that Sweden is in the forefront in terms of several aspects of spent fuel and radioactive waste management, and expressed a desire for Sweden to provide information on developments in these areas in the next report.

It was noted that Sweden demonstrated good practices with regards to:

- Responsibilities for spent fuel and waste safety are clearly defined in the legal framework, see sections A.4.3, A.5.3.1 and E.2.3.5.
- Arrangements in place to finance all items related to spent fuel and radioactive waste management as well as decommissioning, see sections A.5.5.1, E.2.2.5, E.2.2.6, F.2.1.2, F.2.2.2, G.1.3.1 and H.1.3.1.
- A funding mechanism is available for costs for orphan sources and other legacy waste, see sections A.5.5.3 and E.2.2.2.
- A long-term strategy is in place for disposal of spent fuel and nuclear fuel cycle wastes, with defined milestones, see sections A.4, E.2.2.1, E.2.2.2 and G.1.1.

- Provisions for transparency and an extensive public consultation in the decision making process, see sections A.5.6, G.3.1.2, G.3.2.2, G.5.3.2 and K.2.1.
- Constructive communication between regulatory bodies and licensees, see sections A.5.3, E.3.2.5, G.3.3 and G.4.3.

The following challenges were identified for future development as regards management of spent fuel and radioactive waste:

- Continued implementation of the strategy for disposal of spent nuclear fuel and nuclear waste, especially licensing of an encapsulation plant and a spent nuclear fuel disposal facility. Development in this regard is covered in sections A.6.3.1, G.5.2.1 and G.5.3.
- Licensing and implementation of a disposal facility for decommissioning waste. Development in this regard is covered in sections A.6.3.2, H.4 and H5.
- Continued to implement actions from the national action plan for radioactive waste, in particular related to institutional radioactive waste. Development in this regard is covered in section K.4.
- Follow-up of the results of stress tests. Development in this regard is covered in section K.1.4.
- Follow-up of the results of the IRRS mission. Development in this regard is covered in section A.7.4.2.
- Development of waste acceptance criteria for long-lived waste. Development in this regard is covered in sections H.4.3 and H.5.2.

Sweden was asked to report in particular at the next review meeting on the following planned measures to improve safety:

- Licensing of an encapsulation plant and a disposal facility for encapsulated spent fuel. Development in this regard is covered in section G.5.3.
- Licensing of an extension of the existing disposal facility for short-lived low and intermediate level waste (SFR) to also accommodate decommissioning waste. Development in this regard is covered in section H.5.3.
- Development of waste acceptance criteria for long-lived waste. Development in this regard is covered in sections H.4.3 and H.5.2.
- Safety reassessments (stress tests) of nuclear power reactors and the central interim storage facility for spent fuel (Clab) as a consequence of the Fukushima Daiichi accident. Development in this regard is covered in section K.1.4.

A.3 Summary of developments since the previous report

In order to provide continuity from the second review meeting, the rapporteur's matrix has been revised and supplemented with references to explanatory sections of the report in Table A2 below.

TYPE OF LIABILITY	LONG-TERM MANAGEMENT POLICY	FUNDING OF LIABILITIES	CURRENT PRACTICE / FACILITIES	PLANNED FACILITIES
SPENT FUEL	NPP licensees jointly responsible. Strategy in place for disposal.	Funded by fees on nuclear energy production, accumulated in segregated funds (The Nuclear Waste Fund).	Stored on site initially, then transferred to the central interim storage facility (Clab) pending disposal.	Licence application for an encapsulation plant and a spent nuclear fuel repository under review.
See section	*A.5, A.6, B.1.1, E.2.1, K.2.1*	*A.5.5, E.2.2, F.2.1.2*	*A.6.1, A.6.2, B.1.2, D.1.2.3*	*A.6.3, E.2.2.1, G.5.2, G.5.3, K.1.1*
NUCLEAR FUEL CYCLE WASTES	NPP licensees jointly responsible. Strategy in place for disposal.	Mainly funded by fees on nuclear energy production, accumulated in the Nuclear Waste Fund. Disposal of short-lived operational LILW waste (SFR) from NPPs paid for directly by owners.	Short-lived LILW disposal at existing repository (SFR); Shallow land burial sites for short-lived VLLW exist at NPP sites.	Submission of a licence application for extension of the existing repository for short-lived LILW (SFR) is expected in 2014. Long-lived LILW to be disposed of in the planned repository for long-lived LILW nuclear fuel cycle waste (SFL). Licence application expected in 2030.
See section	*A.5, A.6, E.2.1, B.1.4*	*A.5.5, E.2.2.5, F.2.1.2*	*A.6.1, A.6.2.2, B.1.4, D.1.4*	*A.6.3.2, H.5.2*
NON-POWER WASTES	Disposal at fuel cycle waste facilities when appropriate, further actions ongoing.	Financed by producers/ owners of waste. Government funding available for legacy wastes.	Disposal at fuel cycle waste repository (SFR) or interim storage pending disposal in the planned repository for long-lived LILW nuclear fuel cycle waste (SFL).	Submission expected in 2014 of a licence application for extension of the existing repository for short-lived LILW (SFR). Long-lived LILW to be disposed of in the planned repository for long-lived LILW nuclear fuel cycle waste (SFL). Licence application expected in 2030.
See section	*A.6.1, D.1.4.3, K.4*	*A.5.5.5*	*D.1.4.3*	*A.6.3.2, H.5.2*
DECOMMI-SSIONING	Licensee is responsible.	Mainly funded by fees on nuclear energy production, accumulated in the Nuclear Waste Fund.	Preliminary plans for decommissioning exist for all nuclear facilities, more detailed plans for those approaching or undergoing decommissioning. Reviews of the adequacy of funding every three years.	Submission expected in 2014 of a licence application for extension of the existing repository for short-lived LILW (the SFR facility) to accommodate radioactive waste from decommissioning of nuclear facilities. Long-lived LILW to be disposed of in the planned repository for long-lived LILW nuclear fuel cycle waste (SFL). Licence application expected in 2030.
See section	*F.6.1, G.4.2.2*	*A.5.5, E.2.2.5, F.2.1.2*	*A.5.5, F.6.2.1, G.6.2.7*	*A.6.3.2, H.5.2*
DISUSED SEALED SOURCES	Returned to manufacturer.	Financed by producers/ owners of waste. Government funding available for orphan sources.	Returned to manufacturer or disposed of in SFR or in interim storage pending disposal in the planned repository for long-lived LILW nuclear fuel cycle waste (SFL).	To be disposed of in repositories for nuclear fuel cycle wastes, SFR or SFL (if not returned to manufacturer).
See section	*J.1, K.4*	*J.1*	*J.1*	*J.1*

Table A2: Revised overview of the Swedish programme for management and disposal of spent nuclear fuel and radioactive waste.

Licensing review of spent nuclear fuel repository
Since March 2011, the Swedish Radiation Safety Authority (SSM) has been reviewing the Swedish Nuclear Fuel and Waste Management Company's (SKB) licence applications for an encapsulation plant in Oskarshamn and a geological repository for the final disposal of spent nuclear fuel in Forsmark. SSM has completed a review of the quality and completeness of SKB's applications and is now carrying out an in-depth review with resolution of the safety critical review issues. To promote a broad societal involvement in the licensing review, SSM has arranged for two national consultations of SKB's licence applications. The aim of SSM's review is to submit a statement to the Land and Environmental Court[1] in 2015 as a basis for a public hearing, also a final review statement with recommendations to the Government in 2016. See sections G.5.2, G.5.3, K1.1.

International peer review of repository application
An international peer review of SKB's post-closure safety case in the application for a spent fuel repository was organised by the OECD Nuclear Energy Agency (OECD/NEA) in 2011 and 2012, as commissioned by the Swedish Government in 2011. See section A.7.4.1.

Licence application for extension of the SFR disposal facility
In 2014 SSM expects to receive SKB's planned licence application for an extension of the final repository for short-lived low and intermediate level waste in Forsmark (SFR) so that it can also accommodate decommissioning waste. See section H.5.2.

Review of SKB's tenth RD&D programme
SKB's tenth tri-annual research, development and demonstration programme (RD&D programme 2013) was submitted to SSM in September 2013 for evaluation and a public consultation. In its statement in March 2014, the Authority recommended the Government to approve the programme reporting, with the condition that SKB consult with the Authority on the development of more detailed planning on decommissioning activities. See sections G.1.2.1, G.1.3.1, H.1.2.1, H.1.3.1.

Review of SKB's estimation of costs of the future programme
SKB submitted cost estimates in January 2014 for the future management and disposal of spent nuclear fuel and nuclear waste and the decommissioning and dismantling of nuclear facilities. SSM is reviewing the cost estimates and will submit an evaluation to the Government in October 2014 as a basis for a Government decision on the guarantees to be set and the fees per delivered kilowatt-hour of electricity generated to be paid by the nuclear power plant owners to the Nuclear Waste Fund for the years 2015 through 2017. See section G.1.2.1.

Proposal for a revised funding system reducing the state's financial risk
In June 2013, SSM submitted, following a Government assignment, proposals concerning revision of the Financing Act. The mission was carried out in consultation with the Nuclear Waste Fund and the National Debt Office. The

[1] *There are five Land and Environmental Courts. A case is examined by one of these courts.*

authorities have clarified the principles for how the nuclear waste fee is calculated and how the funds in the Nuclear Waste Fund are managed in order to reduce the state's financial risk. See section A.5.5.4.

Implementation of Euratom directive on management of spent fuel and waste
In 2012 SSM submitted a proposal to the Government on the implementation of the Council Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. A total of five regulations have been enacted or revised.

Adjustments were made in the legislation to clarify that export of spent fuel and nuclear waste for disposal in other countries is prohibited unless certain conditions as specified in the directive are fulfilled. Also, by an amendment in 2013 in the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452), SSM shall ensure that there is a present national plan for the management of spent fuel and radioactive waste that corresponds with the contents required under Article 12 of the directive. See sections F.4.1.1, K.3.

National plan for management of all radioactive waste
Based on the actions proposed in the Swedish national plan for the management of all radioactive waste from 2009, SSM has performed investigations on producer responsibility for disused sealed sources and on detection of radioactive materials at the border. SSM has also developed a long-term plan for campaigns to recover orphan sources, and will strengthen the requirements on licensees from the non-nuclear industry to have plans for the safe management of radioactive waste.

SSM is currently updating the plan so that it is consistent with the requirements in Article 12 of the Council Directive 2011/70/Euratom. In connection with this, SSM is establishing a database in order to facilitate the reporting procedures. It is envisaged that the database tool should be appropriately developed to be used for any reporting activities and to support SSM's supervisory activities related to nuclear fuel cycle activities and non-nuclear activities, including inventories. See section K.4.

SSM mandate regarding contaminated sites
A May 2013 amendment of the Ordinance on Supervision under the Environmental Code states that SSM shall provide regulatory guidance regarding supervision of pollution damage and other environmental damage caused by radioactive substances. This mandate enables SSM to more strongly support other regulatory authorities in supervising the cleanup of sites contaminated by radioactive substances. See section E.2.2.4.

Implementation of the Euratom BSS directive
In 2014, SSM received a Government assignment to investigate and propose necessary changes in the legislation due to the Council Directive 2013/59/EURATOM (BSS). The assignment is to be completed by January 31, 2016. See section E.2.2.3.

IRRS mission
In February 2012, SSM underwent an international review of Sweden's compliance with IAEA standards in the form of a full scope IRRS (Integrated Regulatory

Review Service). The need for the regulatory developments identified has been addressed in an action plan that is currently under implementation. In 2014 a follow-up review mission was requested of the IAEA. See section A.7.4.2.

Application for new nuclear reactors
In July 2012, SSM received an application from the power company Vattenfall for the replacement of one or two reactors at the existing sites in operation.

Review and updating of regulations
A revision of SSM's regulatory framework was initiated in 2012, based on both the IAEA recommendations and SSM's own application experience on the need to clarify and supplement its regulations in order to create more predictability for the licensees and to improve the regulatory support for SSM in its supervisory activities. In addition, SSM has been commissioned by the Swedish Government to prepare new regulations in order to develop well adapted and updated requirements for new nuclear power reactors.

SSM is currently preparing the regulations on fundamental obligations for activities involving ionising radiation. The regulations are intended to apply to nuclear activities and any other activities involving ionising radiation. It should be emphasized that regarding nuclear activities, the regulations on fundamental obligations will be supplemented by more detailed requirements on radiation safety. See also the introduction to section E.

Compulsory training programme for SSM personnel
A compulsory training programme for all personnel with supervisory tasks initiated in 2012 is now operational. The aim is to ensure the right level of competence for all supervisory personnel and inspection leaders resulting in more consistent supervisory inspections, regardless of organisational department performing the supervision or the licence holder being supervised. Other developments to further enhance the Authority's supervisory skills include the development of its management system, including the exchange of experiences with other regulatory authorities on supervisory methodologies for radiation safety. See sections A.7.4.2, K.2.3.

Plutonium transfers
In February 2012, the Swedish Government authorized the legacy waste company AB SVAFO to export 3.3 kilograms of separated plutonium from former research and development activities in Sweden to the United States for disposition within the framework of the American Global Threat Reduction Initiative (GTRI). In June 2014 the Government approved the Swedish nuclear power company OKG AB's transfer of its ownership of 834 kg of separated plutonium to the United Kingdom Nuclear Decommissioning Authority, NDA. The material, which is presently stored in the Sellafield facility, is to be managed together with existing UK plutonium for future use in UK reactors in line with UK policies. For more information see section K.5.

Post-Fukushima stress tests
As a follow-up to the TEPCO Fukushima Daiichi nuclear power plant accident, Swedish power plant licensees and SKB conducted renewed safety assessments in 2011 for the reactors and for the interim storage facility for spent nuclear fuel at

Clab in Oskarshamn. In April 2012, SSM required all licensees to present action plans for dealing with the deficiencies identified during these stress tests, and in September, all licensees submitted their action plans. Not being a part of the national action plan for Sweden that was submitted to ENSREG, the European Nuclear Safety Regulators Group, in December 2012, the Clab action plan is continuously monitored through SSM's ordinary regulatory supervision. See section K.1.4.

The European Spallation Source
The Swedish Radiation Safety Authority decided on 17 July 2014 to grant European Spallation Source ESS AB (ESS) authorisation to begin construction of the ESS research facility in Lund. Further permission will be required from the Authority before this facility may be commissioned. The Authority has now granted the company a licence to commence construction of the facility. This means that ESS is allowed to import, acquire and own technical devices and other components for generation of ionising radiation. The ESS application has also been reviewed by the Land and Environmental Court under the Environmental Code, and on 12 June 2014, the court gave ESS conditional approval, see section A.8.

A.4 Development of a national policy for spent fuel and radioactive waste management

The legal framework provides a consistent system with clear allocations of responsibilities, licensing, prohibition, institutional control, regulatory inspections, documentation and reporting. It also enables the enforcement of applicable regulations and terms of the licences. The regulatory body has qualified staff and the financial resources necessary for its activities. The legislation clearly points out the operator as being primarily responsible for the safety of spent fuel and radioactive waste management. The state, however, has the ultimate responsibility for safety aspects of spent fuel and radioactive waste.

The legal framework corresponds very well to the objectives of the Convention. An overview is given in section A.5 followed by a more detailed description in section E.

A.4.1 Past practices

In Sweden, nuclear engineering was launched in 1947, when AB Atomenergi was established to realise a development programme resolved by Parliament. The first research reactor, R1, went critical in 1954 at the Royal Institute of Technology in Stockholm (KTH) and was in operation until 1970. The R1 reactor was followed by the first prototype nuclear power plant (PHWR) in Ågesta, which was mainly used for district heating in a suburb of Stockholm between 1964 and 1974, when it was permanently shut down. Two steam generators were dismantled and waste treated in Studsvik in the early 1990s. Currently, preparations are being made for radiological characterisation and planning of future decommissioning, intended to begin in 2020.

The first commercial nuclear power plant, Oskarshamn 1, was commissioned in 1972 and followed by another eleven units at four sites in southern Sweden: at Barsebäck, Oskarshamn, Ringhals and Forsmark up until 1985, see Figure A1. The

twelve commercial reactors constructed in Sweden comprise nine BWRs (ASEA ATOM design) and three PWRs (Westinghouse design). As a result of political decisions, the twin BWR units Barsebäck 1 and 2 were shut down permanently in 1999 and 2005, respectively.

Other early activities that generated spent fuel and radioactive waste in Sweden include work that took place at the Studsvik site, with two material test reactors (R2 and R2-0) in operation between 1958 and 2005. Preparations for dismantling of the permanently closed down reactors are ongoing.

The uranium mining and milling facilities in Ranstad were constructed and operated in the 1960s. In total about 200 tonnes of uranium were produced. The uranium-open-cast mine and the mill-tailings deposits were restored and covered in the 1990s. Currently, decommissioning of the remaining facility is ongoing and planned to continue until 2016.

Sea dumping of radioactive waste was limited to low-level waste and occurred in Swedish territorial waters as well as in the Atlantic. The last dumping occurred at the end of the 1960s. Sea dumping has been prohibited in Sweden since 1971.[2]

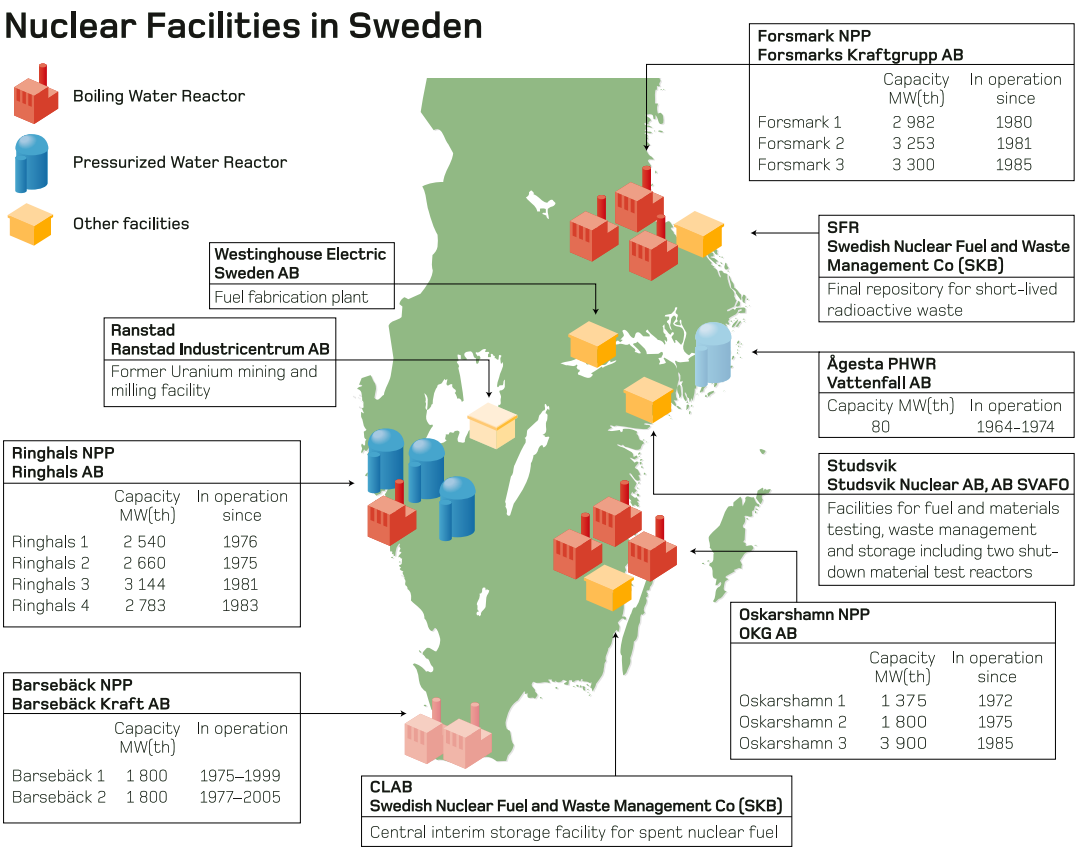

Figure A1: Nuclear facilities in Sweden.

[2] *For more information, see IAEA-TECDOC-1105 available at www.iaea.org and SKI Report 96:78/ SSI Report 96:18 (in Swedish) available at www.ssm.se.*

A.4.2 Milestones in the development of the legal framework

Sweden's first legislation on radiation protection was enacted in 1941 to regulate the risks associated with ionising radiation. Initially, the act referred mainly to medical applications, but the legislation was also applied in 1954 for the licensing of Sweden's first nuclear reactor, R1, at the Royal Institute of Technology in Stockholm.

In 1956 the Swedish parliament decided on the first act that applied specifically to nuclear activities. This act contained the basic requirements for construction and operation of a nuclear reactor. The act was the forerunner to the current Act on Nuclear Activities from 1984.

In the late 1970s, the first requirements were issued concerning the operator's responsibility to safely manage and dispose of nuclear waste as well as ensuring the financing of any costs incurred. It was at that time also stated that an operator must be responsible for research and development programmes in order to safely manage the nuclear waste generated and to safely decommission and dismantle plants no longer to be used.

In 1977 the Parliament promulgated the Stipulation Act, which required a government permit for loading nuclear fuel into a new reactor. A permit could only be issued if the utility presented either an agreement for reprocessing of the spent fuel, or a plan for the safe disposal of the highly radioactive waste. As a result, the nuclear industry initiated a joint project on nuclear fuel safety (KBS) that included the development of disposal methods as well as a wide-ranging siting programme. The first summary report of the KBS project (KBS-l) published in 1977 described a method for the disposal of high activity reprocessed vitrified waste. The report formed the basis of the subsequent Government permission in 1979-1980 to load fuel into newly established reactors. A second summary report (KBS-2) dealing with the disposal of spent non-reprocessed nuclear fuel was issued in 1978. A revised version of the second report, aiming at direct geological disposal (KBS-3), was published in 1983.

In 1981 the Act on Financial Measures laid down the principles for the reactor operators' financing of expenses for decommissioning and disposal of spent nuclear fuel and nuclear waste. The Stipulation Act was in 1984 replaced by the Act on Nuclear Activities, which required the reactor operators to develop a final disposal system in the framework of a research and development programme for the safe handling and disposal of spent fuel and nuclear waste, as described in sections A.5 and E.2.

A.4.3 Fundamental principles

Fundamental principles for the management of spent fuel and radioactive waste have evolved in stages since the 1970s through public debate and a number of policy decisions taken by both the Government and Parliament. These principles are reflected in the Swedish legislation, which is further described in sections A.5 and E.2.

The most important fundamental principles of the national policy are:

1. Costs for the treatment and disposal of spent fuel and radioactive waste from nuclear activities shall be covered by fees that licensees are required to pay.
2. The licensees are to safely dispose of spent nuclear fuel and radioactive waste from nuclear activities.

3. The state has the ultimate responsibility for spent nuclear fuel and radioactive waste from nuclear activities.
4. Each country is to be responsible for the spent nuclear fuel and radioactive waste generated from nuclear activities in that country.

The implementation of these principles in the Swedish legislation in practice constitutes the implementation of the producer pays principle.

The Swedish policy was originally based on the assumption that reprocessing and plutonium recycling would form attractive and desirable elements of the nuclear fuel cycle. As commercial reactors were built in the early 1970s, arrangements were also made to send spent fuel abroad for reprocessing. In the late 1970s, attitudes changed, mainly due to non-proliferation concerns. Since then, the strategy has been direct disposal without reprocessing. In practice, this means that spent nuclear fuel is treated as waste, although it is not legally defined as waste until disposed of in a repository.

A.5 Current legislative and regulatory framework

A.5.1 General requirements

The management of spent fuel and nuclear waste is regulated by a series of statutory provisions, of which the main legislative instruments are:

- The Act on Nuclear Activities.
- The Radiation Protection Act.
- The Act on Financial Measures for the Management of Residual Products from Nuclear Activities.
- The Environmental Code.

Under the Act on Nuclear Activities, the holder of a licence for nuclear activities is primarily responsible for the safe handling and disposal of spent fuel and radioactive waste produced in the activity. In addition, under the Radiation Protection Act, the licensee must take all the measures and precautions necessary to prevent or counteract injury to human health and the environment due to radiation.

The Act on Financial Measures is an essential part of the Swedish nuclear waste management system since it lays down the principles for the financing of expenses for decommissioning and disposal of spent nuclear fuel and nuclear waste.

The Environmental Code contains basic environmental principles such as the precautionary principle, the principle of best available technology, the polluter pays principle, the principle of conservation of natural resources and the principle of selection of the most appropriate location where the purpose of the activity can be achieved with minimum of damage and detriment to human health and the environment. The Code also contains rules on environmental impact assessments.

In relation to the development of nuclear power in Sweden and otherwise to international developments in the field of radiation protection and safety, the Act on Nuclear Activities and the Radiation Protection Act with related ordinances and regulations have over the years been amended with more stringent requirements. See section E for a more complete description of the legal and regulatory framework.

As stated above, the holder of a licence to operate a nuclear facility has the primary responsibility for maintaining safety, ensuring the safe handling and

disposal of spent fuel and radioactive waste and the safe decommissioning and dismantling of facilities in which nuclear activities will no longer be conducted.

These general requirements are supplemented by more detailed regulations issued by SSM and, if needed, licence conditions that the Authority may specify in individual cases.

Swedish nuclear power plant licensees also have some important shared obligations:

- they must in cooperation establish and carry out a research and development (R&D) programme for the safe handling and disposal of spent fuel and nuclear waste (see also section A.5.4), and
- they must in cooperation carry out cost estimates for management and disposal of spent fuel and nuclear waste as a basis for payments to be made to the Swedish Nuclear Waste Fund (see also section A.5.5).

Licensee responsibilities are schematically illustrated in Figure A2.

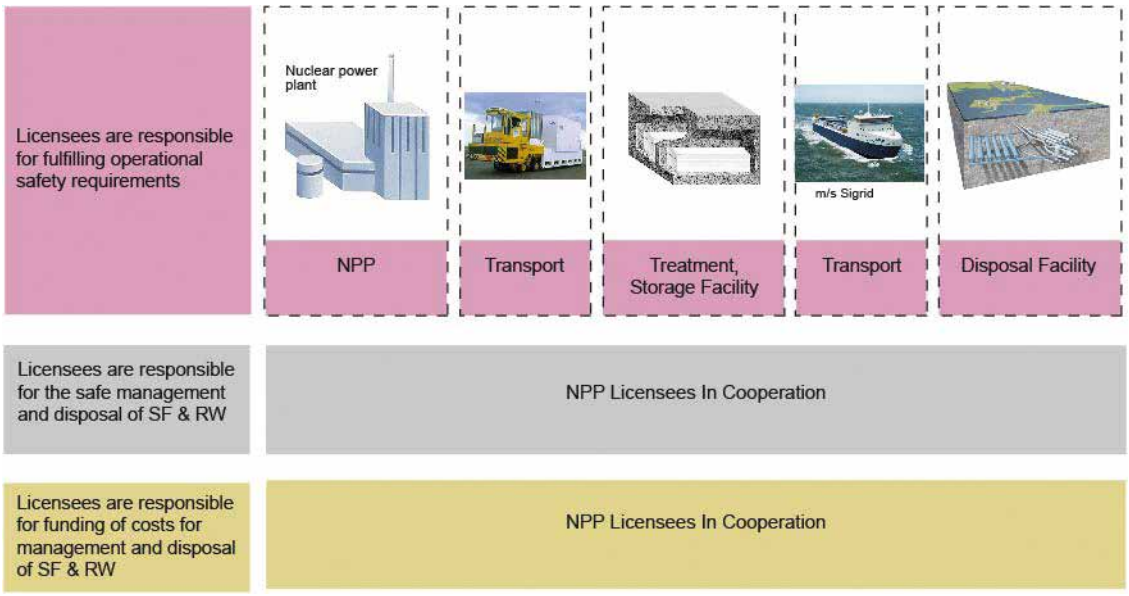

Figure A2: Licensee basic requirements and general obligations.

The four utilities operating nuclear power reactors established the Swedish Nuclear Fuel and Waste Management Company, SKB, to fulfil the above-mentioned obligations and to assist them in executing their responsibilities. At present, SKB is responsible for all handling, transportation and storage of spent fuel and nuclear waste outside the nuclear power plants and operates the Clab and SFR facilities.

SKB is also responsible for the planning and construction of facilities required for the management of spent nuclear fuel and radioactive wastes, and for such research and development work as is necessitated by the provision of such facilities. SKB is also responsible for co-ordination and investigations regarding the costs associated with spent fuel, radioactive waste and future decommissioning of the nuclear power plants and other nuclear facilities.

The adequate financial resources to ensure the fulfilment of these responsibilities and to maintain qualified staff are provided through disbursements from the Nuclear Waste Fund and, in the case of operational radioactive waste, directly by the nuclear power utilities.

For non-nuclear activities, the Radiation Protection Act requires all parties that have produced radioactive waste to ensure the safe management and disposal of the waste, including securing financial resources. This applies to all non-nuclear activities where radioactive material is used: medicine, industry, agriculture, research and education; see section A.5.5.5.

A.5.2 Licensing

Any new nuclear facility must be licensed according to both the Act on Nuclear Activities and the Environmental Code. In both cases the Government grants the licence on the basis of recommendations and reviews of the competent authority.

A key element in the regulatory framework is the clearly defined step-wise licensing process, see Figure A3.

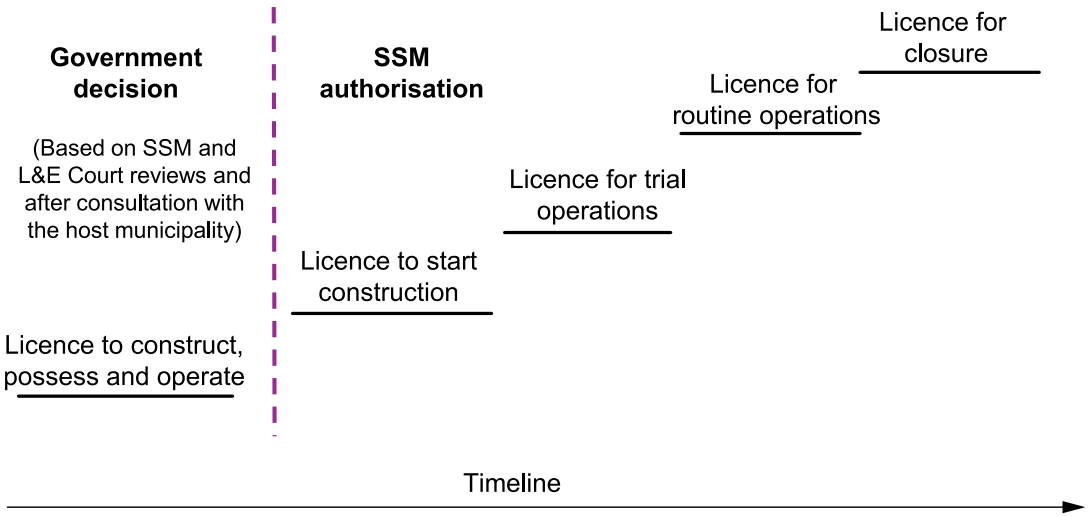

Figure A3: The step-wise process of regulatory authorisation and supervision following a Swedish Government decision licensing a nuclear facility.

A Government licence is needed for the construction, possession, operation and decommissioning of a nuclear facility. The licence thus covers the whole lifecycle of the facility. A licence application is reviewed by the regulatory body and the Land and Environmental Court before the Government's decision.

Following Government approval, the regulatory authority (SSM) authorizes the start of construction, the start of trial operations, the start of routine operations, and the decommissioning of the facility. A Government decision is again needed for de-licensing and the exemption from responsibilities. The authority reviews the application to ensure that all obligations and licensing conditions have been fulfilled.

The safety analysis report (SAR) is central in the review process and must be kept up to date throughout all the steps. The SAR should provide an overall view of how the safety of the facility is arranged in order to protect human health and

the environment against nuclear accidents. The report is to reflect the facility as it is built, analysed and verified, as well as show how the requirements on its design, function, organisation and activities are met.

In addition, and as appropriate, SSM examines the organisational, human and administrative capacity to carry out work to the extent and the quality required as well as preliminary plans for decommissioning of the facility.

SSM also approves the routine operations at least every ten years through the Periodic Safety Review, PSR. This is to determine whether the necessary conditions exist to operate the facility in a safe manner until the next review.

A.5.3 Regulatory control and supervision

A.5.3.1 Roles and responsibilities

SSM supervises SKB, the power plant operators and other licensees of nuclear activities in fulfilling their responsibilities for safe operation of facilities and transports as well as in planning for decommissioning and disposal. SSM is provided with the adequate level of authority, competence and financial and human resources to fulfil its assigned responsibilities. The legislation gives the regulatory authority a strong mandate as well as extensive supervisory and enforcement powers. As a regulator, SSM is authorized to issue legally binding requirements regarding all aspects of nuclear activities and radiation protection.

A.5.3.2 Independence of the regulatory authority

The regulatory body's independence is of fundamental importance in the Swedish constitution. Although the Government has quite substantial scope for steering the operations of government agencies, it has no power to intervene in an agency's decisions in specific matters relating to the application of the law or the due exercise of its authority, i.e. authorization, supervision, etc. The Swedish Parliament is responsible for monitoring to ensure that "ministerial rule", i.e. the Government officials instructing agencies in individual matters, does not occur.

While SSM is an independent regulator, the final decision-making authority for issuing a licence for a nuclear facility rests with the Government. SSM functions as the competent authority with the technical expertise to review a licencing application and advise the Government.

Although the independence of the regulator is stated in Swedish legislation, it is also a matter of public service culture and values. A strong, independent and fully accountable national authority is also confident and trustworthy in upholding high safety standards. As an example, the integrity of SSM has become increasingly vital with the progression of the licensing review of SKB's application for a spent fuel repository. Strict internal rules apply to the interaction with the applicant and to independence from the nuclear industry. All staff and contracted experts have been screened to ensure that they have not been associated with SKB-related activities.

A.5.3.3 Regulatory inspections

In accordance with its legal authorisation and the mandate defined by the Government, the regulatory authority conducts regular inspections and assessments of the nuclear facilities to ascertain compliance with regulations and licence conditions. Supervision of compliance with the Act on Nuclear Activities and the

Radiation Protection Act, as well as conditions or regulations imposed under the Acts, is carried out by SSM. SSM also fulfils supervision of the compliance with the Environmental Code and conditions or regulations imposed by the Code for questions concerning radiation safety.

The implementer must on request submit information to the Authority and provide the documentation required for its supervision. The Authority must also be given access to the installation or site where the activities are conducted for investigations and sampling to the extent required for supervision.

SSM's supervisory practices for nuclear installations include compliance inspections with respect to requirements found in regulations, licensing conditions and to some extent in regulatory decisions. The ambition is to systematically supervise the safety situation and monitor developments based on a comprehensive inspection programme. The documented inspection findings provide a basis for SSM's annual integrated evaluation of radiation protection and safety on the part of each nuclear facility.

A.5.3.4 Documentation and reporting

SSM's Regulatory Code, SSMFS, stipulates extensive reporting from licence holders. Annual reports are required to be submitted to SSM on activities at the facility including experience gained and conclusions reached with regard to safety, on the management of nuclear waste and on high activity sources (HASS). A deficiency detected during the construction or operation of a nuclear facility, and that can lead to deterioration in safety in addition to what is anticipated in the safety analysis report, must be reported to SSM without unnecessary delay.

According to regulations on radiation protection, the licence holder must conduct environmental monitoring. All discharges from facilities for storage or disposal of radioactive waste must be monitored by a nuclide-specific measuring programme. The dose to any individual in the critical group must not exceed 0.1 mSv/y. The licence holder of a nuclear facility must also report to SSM on the discharge of radioactive substances into air and water, shown as discharge of activity, and doses to individuals in a reference group, also the results of environmental monitoring. The measures that have been taken or are planned to be taken in order to limit the discharge of radioactive substances should also be reported. If the reference values are exceeded, the measures planned with a view to reaching the reference values must be reported.

At least once every ten years, licensees are required to perform a periodic safety review (PSR), i.e. an integrated analysis and assessment of the safety of a facility. The periodic safety reviews are submitted to the regulatory authority, which conducts a comprehensive review and assessment of the submitted review and its references, which is then documented in a review report. In the case of nuclear power reactors, the report is submitted to the Government.

A.5.3.5 Prohibition and enforcement

The authorities have extensive legal regulatory and enforcement powers. If there is an ongoing licensed activity that does not comply with regulations or the terms of the license, the supervisory authorities may issue any injunctions and prohibitions required in the specific case to ensure compliance. Injunctions or prohibitions under the Acts may carry contingent fines.

A licence to conduct nuclear activities may be revoked by the authority issuing the permit if conditions have not been complied with in some essential respect or there are very specific reasons from the viewpoint of safety. A revocation of a licence may therefore be decided in cases of severe misconduct by the operator or otherwise for exceptional safety reasons. If the licence to operate a nuclear activity is revoked, the licence holder remains responsible for waste management and decommissioning.

If a person fails to carry out a measure incumbent upon him or her under the Acts, Ordinances, regulations or conditions issued pursuant to the Acts, or under the supervisory authority's injunction, the authority may arrange for the measure to be taken at the individual's expense.

A.5.4 National RD&D programme

The Act on Nuclear Activities requires from the power plant operators a programme of comprehensive research and development and any other measures needed to manage and dispose of spent nuclear fuel and nuclear waste in a safe manner and to decommission and dismantle the nuclear power plants. A report describing SKB's research and development work (denoted as the programme for Research, Development and Demonstration, or the RD&D programme, since 1992) must be submitted to the regulatory authority every three years for review and for a public consultation. The report is to include an overview of all measures that may be necessary and specify the action to be taken within a period of at least six years. Based on SSM's review recommendations, the Government approves or rejects the general direction of the continued programme. In connection with the decision, the Government may issue conditions on the content of SKB's future research and development work.

Since 1986, SKB has on the behalf of the nuclear power plant licensees carried out and reported on ten research, development and demonstration (RD&D) programmes, with the KBS-3 method being the main alternative for the geological disposal of spent fuel. An important goal of the programme was fulfilled when a licence application for a permit to build a disposal facility for spent nuclear fuel was submitted to SSM and the Land and Environmental Court on March 16, 2011 (see sections A.6.3, G.5.2).

The most recent RD&D programme was published by SKB and submitted to SSM in September 2013. In its statement in March 2014, SSM advised the Government to approve the programme reporting, with the condition that SKB, in cooperation with the nuclear power reactor operators, is to consult with the Authority on the development of more detailed planning on decommissioning of the reactors.

The continued RD&D programmes should also investigate parameters relevant for a spent fuel disposal system. This include the decommissioning of nuclear facilities, the extension and future operation of the disposal facility for short-lived low and intermediate level operational waste (SFR), the extension of SFR to accommodate decommissioning waste, and the planning, development and research as regards a future disposal facility for long-lived radioactive waste (SFL).

The management system, as presented in SKB's RD&D programme 2013 for spent fuel and nuclear waste, with the facilities that remain to be realised, is described in section A.6.

A.5.5 The financing system

A.5.5.1 Nuclear power plants

The financing system was established in 1981 to secure the financing of the nuclear power plant licensees' future costs for the management and disposal of spent nuclear fuel and nuclear waste.[3] The main objective is to minimize the risk of the state and future generations being forced to bear costs considered to be the liability of licensees. If there is insufficient money in the funds to pay for the costs, the nuclear industry will still be liable.

The nuclear power utilities' cost estimates are coordinated by SKB and submitted to the regulator, SSM, every three years for review. SSM reviews the cost estimates and calculates the fees and guarantees to be set individually for each utility. The reference scenario is based on the reactor owners' current plans for future reactor operation. The fees are calculated on the assumption that each reactor will generate electricity for 40 years, but always with a minimum remaining operating time of six years. Based on SSM's statement, the fees to be paid to the nuclear waste fund and the guarantees are decided on by the Government for a period of three years. The management of this nuclear waste fund is the responsibility of a separate government agency: the Nuclear Waste Fund. The Swedish National Debt Office administrates and manages the guarantees.

Two separate guarantees must be provided by the power plant utilities:

- to cover the shortfall if a reactor is closed before it has reached its 40 years of operating time, and
- to cover costs in connection with unexpected events.

To date, the Nuclear Waste Fund has covered SKB's expenses for the central interim storage facility for spent nuclear fuel (Clab), for the transport system and for the research and development activities, laboratories, siting and feasibility studies included. Future expenses should cover the encapsulation plant for spent fuel, repositories for spent fuel and long-lived low and intermediate level waste, the decommissioning and dismantling of nuclear power plants, the disposal facility for decommissioning waste and the continued research and development work. The waste fund also finances regulatory control and supervision following closure of reactors.

The Government decided in 2011 to increase the fee from an average of SEK 0.01 per kWh of produced nuclear electricity (ca EUR 0.9 per MWh) to an average of SEK 0.022 (ca EUR 2.0 per MWh) for the period 2012-14. On October 7, 2014, at the latest, SSM is to submit the review results of SKB's 2013 cost estimates to the Government, with an updated proposal for fees and guarantees to be decided for the period 2015-2017.

A.5.5.2 Other nuclear facilities

Licensees other than nuclear power reactor operators must also pay fees to the Nuclear Waste Fund. The cost estimates and the build-up of adequate financial resources are to be based on the expected remaining period of operation. The

[3] *Costs for the management of operational radioactive waste are paid for directly by the nuclear power utilities.*

licensees of nuclear facilities other than nuclear power reactors must also provide a guarantee to cover the discrepancy between funded means and estimated costs.

The nuclear waste fees and guarantees for other nuclear facilities are decided on by the regulatory authority, SSM, for a period of three years.

A.5.5.3 Legacy waste

There is also a funding mechanism for legacy waste from historic nuclear activities. A special fee is levied on the nuclear power utilities according to what is referred to as the 'Studsvik Act'. The fee is intended to cover expenses for the decommissioning of the research reactors in Studsvik, the Ågesta reactor and the uranium mine in Ranstad.

The Studsvik Act stipulates a set fee of SEK 0.003 per kWh of produced nuclear electricity (ca EUR 0.3 per MWh). The Act is in effect until 2017, when the fund should be complete. SSM reviews the fee on a yearly basis and can propose changes in legislation to the Government if needed.

In addition, there is a state financing scheme for the cleanup of orphan sources and other legacy waste that is administered by SSM.

A.5.5.4 Financing system oversight

In 2011, the Swedish Government assigned SSM to, in consultation with the Nuclear Waste Fund and the Swedish National Debt Office, review the Act (2006:647) and the Ordinance (2008:715) on Financing of Management of Residual Products from Nuclear Activities. The purpose was to clarify the principles for calculating nuclear waste fees and managing the assets in the Nuclear Waste Fund, while also reviewing the provisions concerning use of guarantees for the purpose of improving the level of financial security on the part of the state.

Significant material changes proposed by the authorities in their June 2014 report were:

- to broaden the investment opportunities of the Nuclear Waste Fund,
- to link the discount rate curve to the Nuclear Waste Fund's anticipated yield and to stipulate the calculation principles in the Act and Ordinance,
- to base the computation of fees on 50 years of operation on the part of nuclear power reactors in operation,
- to broaden the guarantee on contingencies in order to cover risks in terms of both assets and liabilities, in addition to their being computed by the state, and
- to implement an option to claim guarantees provided in cases where the fund assets of a fee-liable licensee cannot be expected to cover the expenses and this licensee undertakes no other measures.

Other changes that were proposed in the authorities' report mainly served to provide clarifications and to increase the level of precision in the regulatory framework. In addition to the proposed statutory amendments, the authorities have identified a need for continued development of analysis methods for the computation of fees and guarantees.

Implementing the proposed amendments will result in a financing system reducing the financial risk for the state. A broadening of investment opportunities and a computation of fees based on 50 years of operation will result in a substantial

lowering of the nuclear waste fee. As a consequence, the guarantee amount for unexpected events will increase. The calculation of fees is also very dependent on the level of quality of the underlying estimates produced by the nuclear power industry, e.g. assessments of decommissioning costs, future productivity development and forecasts on nuclear power production.

A.5.5.5 Non-nuclear activities

According to the Radiation Protection Act, any party that has produced radioactive waste is required to ensure the safe management and disposal of the waste, including securing financial resources. This applies to all non-nuclear activities where radioactive material is used: medicine, industry, agriculture, research and education. Radioactive waste that is to be disposed of is sent to Studsvik Nuclear AB, the only recognized radioactive waste management facility in Sweden, for treatment and storage prior to disposal. As far as concerns radioactive waste to be disposed of in SFR, the waste producer pays a fee to Studsvik Nuclear AB that covers the costs for all steps of the management of the waste, with the exception of the disposal itself. In 1984 the Government agreed on a one-off compensation payment to Studsvik Nuclear AB (then Studsvik Energiteknik AB) to cover the future costs for the disposal in SFR of all radioactive waste originating from non-nuclear activities, among other things. When radioactive waste is to be disposed of in SFL, the fee to Studsvik Nuclear AB includes the cost for this disposal.

A.5.6 Provisions for openness and transparency

Building public confidence and acceptance in the management system for spent nuclear fuel and radioactive waste strongly benefits from a national system with consistent long term strategies and planning. As stated above, the financial arrangements are in place and working since almost 30 years, a research and development programme for waste management and disposal has been continuously ongoing for more than 30 years and the long term strategies are being implemented. The Clab and SFR storage and disposal facilities, respectively, have been in operation since the 1980s, an application for a spent fuel repository has been undergoing review since 2011, and in 2014 an application for the extension of the SFR facility to accommodate decommissioning waste is expected.

The legal framework for licensing of nuclear activities also contains provisions governing transparency, openness and public participation. According to the Environmental Code, a prospective licensee is required to submit an Environmental Impact Statement. This statement must contain a plan for the formal process of consultation with stakeholders.

Through the mandatory review of RD&D programmes and cost estimate reports, SSM and the former authorities have been able to supervise the development of management and disposal systems in the pre-licensing process. In addition to the regulatory involvement and strategic Government decisions, the review process has also included the possibilities for broad public participation in the development of a Swedish management system for spent fuel and radioactive waste.

As an example, SKB's siting process for a spent fuel repository has involved local communities on a voluntary basis, with the possibility to end participation during all stages. To enable active participation in formal consultations during

the licensing process, host municipalities, regional authorities and certain environmental organisations receive financial support through the Nuclear Waste Fund. Preceding the Government's licensing decision, the host municipality concerned has a right to veto and is to formally declare its support or rejection of the decision. In practice, these arrangements have thus far been very beneficial to the overall quality and public acceptance of the repository licensing process.

The Swedish approach to building trust in the high level waste management system as well as to regulator integrity was credited a good practice in the 2011 IAEA IRRS review.

A.6 The management system for spent nuclear fuel and radioactive waste

A.6.1 Generation of spent fuel and radioactive waste

Twelve nuclear reactors were built in the 1970s and 1980s at four sites in southern Sweden. Ten reactors are presently in operation at three sites giving rise to radioactive waste and spent nuclear fuel. The reactors at the Forsmark, Oskarshamn and Ringhals nuclear power plants provide about 45 % of Sweden's total electrical power production. Two reactors at the Barsebäck site have since 1999 and 2005 been permanently closed down in line with previous political decisions to phase out nuclear power in Sweden. A Parliament decision in 2010 opened up the possibility of new builds, and in 2012, SSM received an application from the Vattenfall power company for the replacement of one or two reactors at existing sites in operation. Figure A1 illustrates the geographical location of Swedish nuclear facilities.

The national strategy for spent nuclear fuel is direct disposal without reprocessing, i.e. spent fuel is managed as waste and not as a resource in the Swedish programme.[4] The spent fuel, after cooling on the reactor site, is transported by ship to the central interim storage facility, Clab, located next to the Oskarshamn power plant.

A final repository for short-lived low and intermediate level operational waste, the SFR facility, is located next to the Forsmark power plant.

The nuclear power plants at Ringhals, Forsmark and Oskarshamn, and the Studsvik site, also have shallow land burials on site for solid short-lived low level operational waste.

Other Swedish fuel cycle facilities include:

- The Westinghouse fuel factory in Västerås, central Sweden.
- The Studsvik site, with waste treatment facilities for both nuclear and non-nuclear waste, as well as closed down research reactors that are under preparation for decommissioning.
- The closed down uranium extraction facility in Ranstad that is under decommissioning.

[4] *There are, however, no legal restrictions against reprocessing. Justification of direct disposal is one of the issues addressed in the ongoing licensing review of the application for construction of a spent nuclear fuel repository.*

- The Ågesta nuclear power station that was in operation between 1964 and 1974. This was the first commercial NPP in Sweden. Its primary function was to provide district heating to the Stockholm suburb of Farsta.

Operational radioactive waste is produced at the nuclear reactors and fuel cycle facilities. Radioactive waste also originates from medical and research institutions, industry and consumer products. Past research activities have also generated some waste, which is either stored or has already been disposed of.

In total, the Swedish nuclear power programme will generate approximately 20,000 m^3 (12,600 tonnes) of spent fuel, 155,000 m^3 of short-lived LILW from operations and decommissioning and 15,000 m^3 of long-lived LILW (based on 60 years of operation of the reactors, with the exceptions of Ringhals 1 and 2 which will be operated for 50 years). Total annual production of LILW at the nuclear facilities is usually around 1,000-1,500 m^3.

All transportation of spent nuclear fuel and radioactive waste is by sea, since all the nuclear facilities are situated on the coast. The transportation system has been in operation since 1982 and consists of a dedicated ship, transport casks and containers, and terminal vehicles for loading and unloading. Figure A4 schematically illustrates the management system for spent nuclear fuel and radioactive waste.

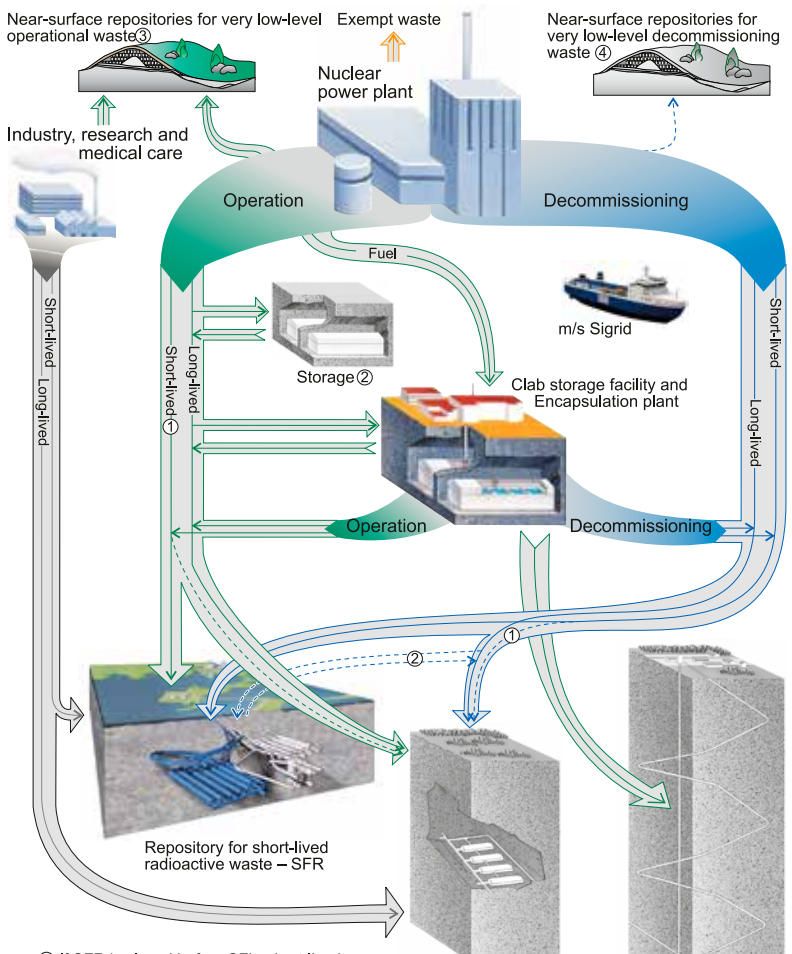

Figure A4: Management system for spent nuclear fuel and radioactive waste as presented in the RD&D programme 2013.

The original ship, M/S Sigyn, was replaced with a new ship, M/S Sigrid, in the beginning of 2014. M/S Sigrid was built between 2011 and 2013 in Galati, Romania, by the Damen Shipyards Group, see Figure A5 and Table A3. The international maritime organisation (IMO) has given her the highest classification, level INF 3 for ships that transport radioactive waste. The ship represents an advance in relation to M/S Sigyn in terms of compliance with new requirements and regulations.

Figure A5: M/S Sigrid, the new transport ship for spent nuclear fuel and radioactive waste.

Facts about M/S Sigrid	
Overall length	99.5 metres
Beam	18.6 metres
Primary cargo	Radioactive waste and spent fuel
Cargo capacity	12 transport casks or 40 freight containers
Draught	4.5 metres
Deadweight tonnage	1,600 tonnes
Cruising speed	8-12 knots
Engine power	Four main engines, 825 kilowatts each

Table A3: Facts about M/S Sigrid.

Facilities that remain to be realised are an encapsulation plant for spent fuel, repositories for spent fuel and long-lived low and intermediate level waste, and an extension of SFR for decommissioning waste. SKB's RD&D programme 2013 focuses on these aspects.

Research and demonstration facilities include the underground Äspö Hard Rock Laboratory for the investigation of engineered and geological repository barriers, the Canister Laboratory for the development of a sealing technology for copper canisters, and the bentonite laboratory for the testing of buffer properties and development of methods for the backfilling and plugging of repository tunnels. All facilities are situated in the Oskarshamn area.

A.6.2 Facilities overview

A.6.2.1 Spent nuclear fuel management practices and facilities

Management practices at the NPP sites
Spent nuclear fuel from the nuclear power reactors is temporarily stored in water filled fuel pools for at least nine months before being transported to the central interim storage facility for spent nuclear fuel (Clab).

The central interim storage facility for spent fuel, Clab
The spent nuclear fuel from all Swedish nuclear power reactors is stored in a central interim storage facility, Clab, situated adjacent to the Oskarshamn nuclear power plant. Approximately 100 persons work at the facility.

The facility consists of two parts: one building above ground for unloading spent fuel assemblies from transport casks, and one underground part for storage with a rock cover of about 25-30 metres. The storage part consists of two caverns approximately 120 metres long, each containing five storage pools in which the spent fuel will be stored for at least 30 years before being encapsulated and deposited in a repository.

The construction of Clab started in 1980 and the facility was taken into operation in 1985 with a storage capacity of 5,000 tonnes of spent fuel. Due to an increase in storage capacity in 2008, the current total storage capacity is approximately 8,000 tonnes of spent fuel, and 5,740 tonnes were being stored at the end of 2013. A photo from one of the storage pools is shown in Figure A6. Principal data as well as information on inventories are contained in section D.1.2.3.

Figure A6: Storage pool in Clab.

Management practices at the nuclear sites
Most of the low and intermediate level radioactive wastes (LILW) are conditioned (solidified, compacted, etc.) at the point of origin, i.e. at the reactor sites. Some wastes are sent to Studsvik's waste treatment facilities for incineration or melting.

Repository for radioactive operational waste, SFR
SFR is designed for the disposal of short-lived low and intermediate level radioactive waste from the Swedish nuclear power plants, Clab, and for similar waste from other industry, research and medical usage. SFR is situated approximately 140 kilometres north of Stockholm, close to the Forsmark nuclear power plant. Approximately 40 people work at the facility.

SFR consists of four rock caverns and a silo. The facility is situated in crystalline bedrock, approximately 50 m below the seabed at a water depth of 5 m. Construction started in 1983 and it was taken into operation in 1988. The total capacity is 63,000 m^3 and about 42,000 m^3 had been used by 31 December 2013. A photo from the top of the silo is shown in Figure A7. Principal data as well as information on inventories are contained in section D.1.4.4.

SKB is planning an extension of SFR in order to dispose of additional operational waste and waste from future decommissioning of nuclear power plants and other nuclear facilities, see section H.5.2. SKB intends to submit a licence application in 2014 and operation is planned to commence in 2023.

Figure A7: Photo from the top of the silo in SFR.

Shallow land burials
The nuclear power plants at Ringhals, Forsmark and Oskarshamn, as well as the Studsvik site, have shallow land burials for solid short-lived low-level operational waste (<300 kBq/kg). Each burial is licensed for a total activity of 100 - 200 GBq (the highest level according to the legislation is 10 TBq, of which a maximum of 10 GBq may consist of alpha-active substances).

Clearance
Material may be cleared for unrestricted use or for disposal as conventional non-radioactive waste (see also sections E.2.2.3, E.2.3.1, F.6). For example, in 2004 approximately 600 tonnes were cleared for disposal at municipal landfills. In addition, 764 tonnes of melted metal (<500 Bq/kg) were cleared for recycling in 2010.

A.6.2.3 Research and demonstration facilities

The Äspö Hard Rock Laboratory
The Äspö Hard Rock Laboratory (HRL), which was built during the period 1990-1995, is situated on the island of Äspö north of the Oskarshamn nuclear power plant. The underground laboratory consists of a tunnel from the Simpevarp peninsula, where the Oskarshamn nuclear power plant is located, to the southern part of Äspö. At Äspö the main tunnel descends in two spiral turns to a depth of 460 metres. The various experiments are conducted in niches in the short tunnels that branch out from the main tunnel. An illustration of the HRL is shown in Figure A8.

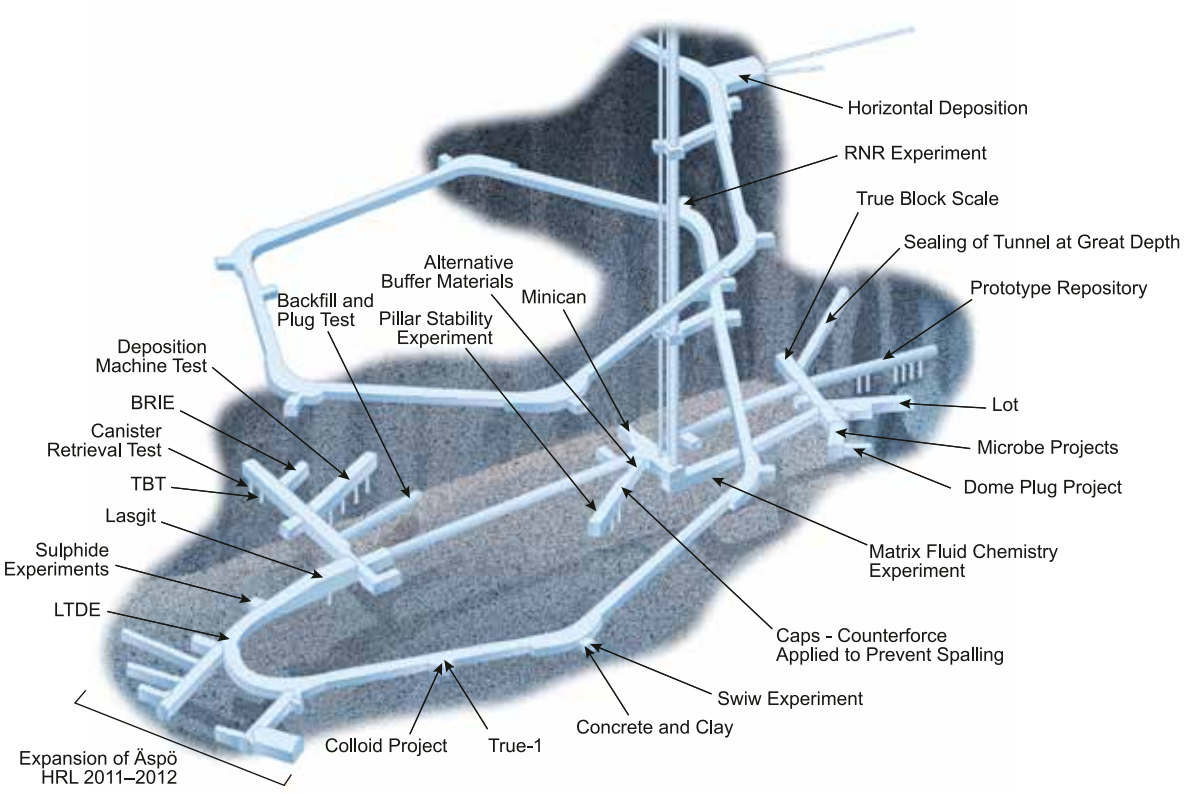

Figure A8: The underground parts of the Äspö Hard Rock Laboratory.

The laboratory is used to investigate how the barriers in the repository for spent nuclear fuel (canister, buffer, backfill, closure and rock) prevent the radionuclides in the fuel from reaching the ground surface. Also, research regarding LILW is performed at the Äspö HRL. Development and demonstration of equipment to be used in future facilities are important parts of the HRL activities as well. The Äspö HRL is planned to be in operation at least until the commissioning of the spent fuel repository.

The Canister Laboratory

The Canister Laboratory, situated in the harbour area at Oskarshamn, was built during the period 1996-1998. One of the shipyard's old welding halls has been converted for use in the development of the sealing technology for copper canisters. Mainly equipment for welding of copper lids and bottoms and for non-destructive testing of the welds and the different parts of the canister is developed. Equipment and systems for handling spent nuclear fuel and canisters are also tested and developed in the laboratory. The facility will also be used for training of personnel in preparation for the commissioning of the encapsulation line in the combined storage and encapsulation facility, Clink. The Canister Laboratory is therefore planned to be in use until encapsulation of the spent nuclear fuel commences.

There are stations in the Canister Laboratory for testing different welding techniques and different methods for non-destructive testing. The goal is to develop methods that meet the stipulated quality requirements and have sufficiently high reliability to be used in Clink. The most important items of equipment in the laboratory are a friction welder (see Figure A9), an electron beam welder and equipment for radiographic and ultrasonic testing. Friction stir welding has been selected as the reference method for welding of the lids of the copper canisters.

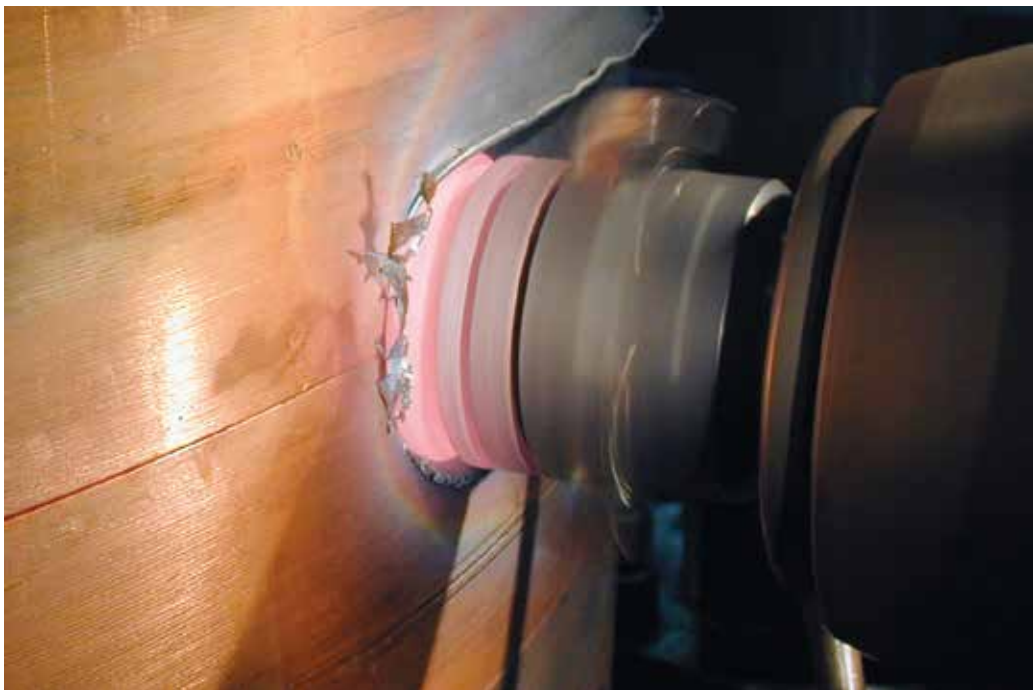

Figure A9: Friction stir welding at the Canister Laboratory.

The Bentonite Laboratory
SKB has been conducting research and development in the Bentonite Laboratory in Oskarshamn since 2007. The facility is situated adjacent to the Äspö HRL and supplements the experiments being conducted there, see Figure A10.

In the Bentonite Laboratory, the properties of the bentonite are tested by (for example) simulating water conditions in a controlled manner. Here, SKB is also developing methods for backfilling the repository's tunnels and building plugs to seal the deposition tunnels.

Figure A10: The Bentonite Laboratory at Äspö.

A.6.3 Planned facilities
The facilities that remain to be designed, constructed and licensed are as follows: an extension of the Clab facility with a plant for encapsulation of spent nuclear fuel, a repository for spent fuel, an extension of the existing repository, SFR, mainly for short-lived low and intermediate level waste from decommissioning and dismantling of nuclear power plants, and a repository for long-lived low and intermediate level waste (SFL).

On March 16, 2011, SKB submitted an application under the Act on Nuclear Activities for final disposal of spent nuclear fuel and an application under the Environmental Code for the KBS-3 system. An application under the Act on Nuclear Activities for the encapsulation plant was submitted in 2006 and supplemented first in 2009 and thereafter in conjunction with the applications submitted in March 2011.

A.6.3.1 Facilities for spent nuclear fuel

The main alternative for disposal of spent fuel, KBS-3, involves emplacement of fuel elements in copper canisters (corrosion resistance) with cast iron inserts (mechanical strength), see Figure A11. The canisters will be embedded in bentonite clay (protection against corrosion and rock movements, preventing water penetration and leakage of radioactive substances) in individual deposition holes at a depth of about 400-700 m in the bedrock (maintains the technical barriers for a long time and isolates the spent fuel from human beings and the environment).

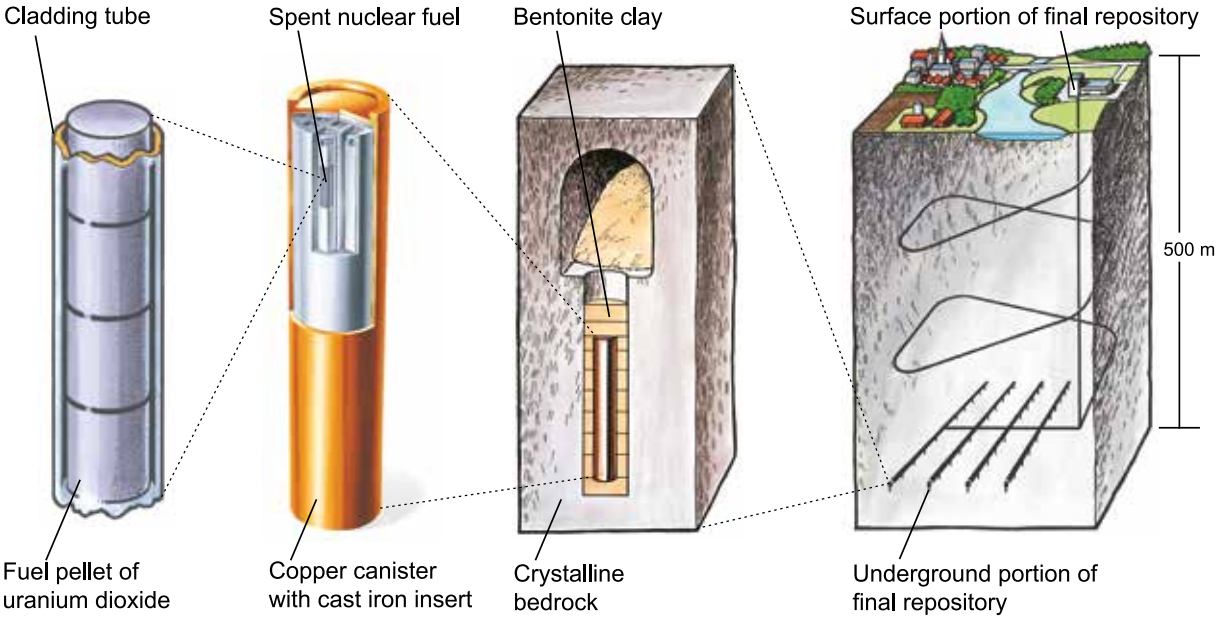

Figure A11: The reference method KBS-3 for disposal of spent nuclear fuel.

SKB's planning for the future management of spent nuclear fuel, from interim storage in Clab via encapsulation to disposal, takes place within the framework of SKB's Nuclear Fuel Programme. The process to construct and commission a new facility or facility part undergoes different phases. The programme includes licensing, design, construction and commissioning of the encapsulation plant and the repository for spent nuclear fuel.

Encapsulation plant for spent nuclear fuel

As mentioned earlier, an application under the Act on Nuclear Activities for the encapsulation plant was submitted in 2006. It was amended in 2009 regarding integration of the encapsulation plant and Clab to a single facility, Clink, and in 2011 regarding parts dealing with the KBS-3 system. The licensing review process is currently (spring 2014) underway, and SKB regularly responds to questions and requests for supplementary information from SSM. The estimated start of construction for the spent fuel repository is 2019, and for the encapsulation part of Clink, 2021. These facilities will then be commissioned in 2029, see Figure A12.

In parallel with the licensing review and up to the start of construction of the encapsulation part, SKB will design Clink and procure its construction. This phase is called the design and procurement phase of the project and will be divided into four partially overlapping sub-phases: facility configuration, system design, detailed design and procurement of construction.

During the facility configuration phase, SKB intends to update the set of requirements for Clink based on requirements identified during technology development and viewpoints expressed by the Authority during licensing, and to modify the facility's preliminary layout as needed.

SKB then intends to proceed with system design of Clink. The further detailing of the design and the activity that occurs in conjunction with this will be described in a preliminary safety analysis report, PSAR, for the integrated Clink facility. SKB will then prepare a project plan for construction of the encapsulation part and changes in the interim storage part.

When SSM has approved the PSAR for Clink, SKB will continue detailed design and carry out the procurements required to commence construction of the encapsulation part and implementation of the changes that need to be made in the interim storage part. SKB will also announce the changes that need to be made in the interim storage part in the form of "change matters" in accordance with the requirements in SSMFS 2008:1. Once SKB has been granted a licence, the procurement phase enters its final stage and the construction phase begins.

Repository for spent nuclear fuel

In the early 1990s, SKB initiated a programme for siting a spent nuclear fuel repository. SKB's time schedule (see Figure A12) for performed and future activities for the disposal of the spent nuclear fuel is as follows:

2005-2009	Site investigations at two sites: Laxemar (Oskarshamn municipality) and Forsmark (Östhammar municipality).
June 2009	SKB selected Forsmark as the site for a repository for spent nuclear fuel.
2011	SKB submitted licence applications for siting and construction of the facility.
2011-2019	Examination of application including review by SSM and the Land and Environmental Court, Government decision and finalisation of PSAR.
2019-2028	Construction and commissioning.
2028	Submission of application for trial operation.
2029-2030	Trial operation.
2030	Submission of application for operation.
2030	Operation.

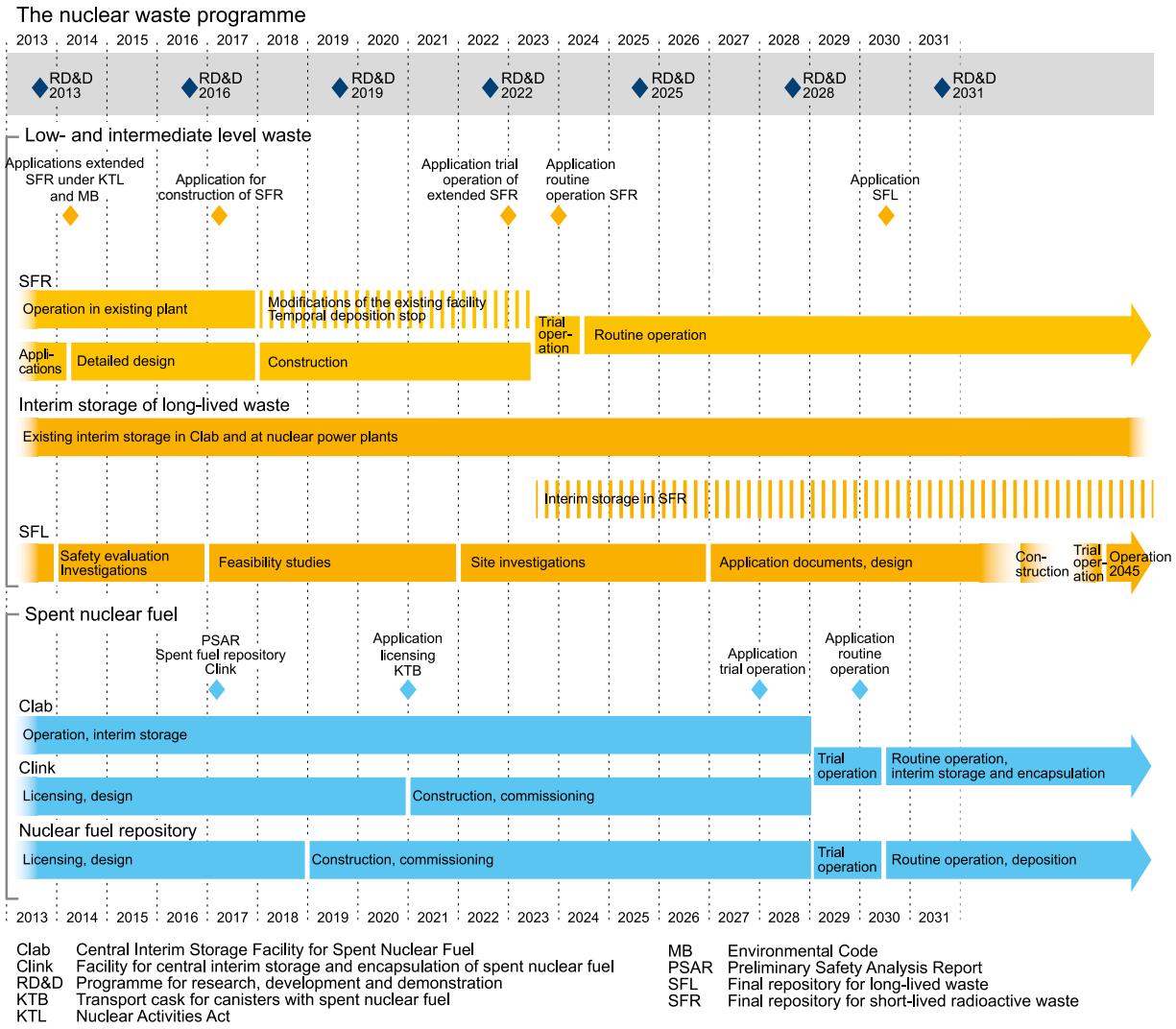

Figure A12: Main timetable for SKB's nuclear waste programme. Hatched bars mark uncertainties and flexibility in the planning.

The applications for a repository for spent nuclear fuel have been submitted to the Land and Environmental Court and to the Swedish Radiation Safety Authority.

The Land and Environmental Court will prepare the case, review it under the Environmental Code and will hold a main hearing. After the Court hearings, the Court will submit a statement to the Swedish Government on the licence applications and recommend a decision. The Government will request statements from the municipalities of Östhammar and Oskarshamn. The municipalities will accept or reject the project and have a right of veto. The Government will then make a decision on whether the final disposal system is permissible or not. If the application is approved, the Land and Environmental Court will hold a new hearing. Thereafter, the Court will grant permits and stipulate conditions pursuant to the Environmental Code.

The Swedish Radiation Safety Authority will prepare the case in accordance with the Act on Nuclear Activities (1984:3) and the Government will grant a permit. The Government grants the permit to the Swedish Radiation Safety Authority, which will stipulate the conditions.

Over the next few years, SKB will gradually prepare the organisation for the start of construction of the spent fuel repository. The start of construction is currently planned for 2019. Each major step in the work is preceded by a decision gate aimed at evaluating the programme from a holistic perspective and establishing a more detailed plan for the period up to the next decision gate.

During the licensing process, the work pace will be adapted to the supplementary information requested from SKB by SSM and new information in the form of comments by regulatory authorities. The most important milestones to be considered are:

- the Land and Environmental Court's and SSM's review statements to the Government, and
- the Government's decisions on licences and permissibility.

As soon as the above milestones are passed, SKB will increase the pace of the preparatory work. For example, extensive efforts relating to detailed design of facility parts and technical systems will be initiated following the Government's decisions on licences and permissibility.

Before construction of the facilities can be commenced, two documents must be submitted and approved by SSM:

- the preliminary safety analysis report (PSAR), which also includes a description of the expansion of the repository's deposition areas and how this affects safety, and
- a document ('Suus') that describes how the construction of the facility affects safety during the operating phase and after closure.

The documents submitted to SSM shall take into account the results of e.g. technology development and design activities since the applications were compiled. The construction projects shall at this time be finished with detailed design and tendering specifications for the first facility parts to be built.

SSM licensing review

Since March 2011, SSM has been reviewing SKB's licence applications for an encapsulation plant and a deep geological repository for the final disposal of spent nuclear fuel. The initial licensing review phase included a broad review of all primary licensing documents in order to conduct a first assessment of the quality and completeness of the applications, the identification of scientific and technical areas for in-depth review, and requests for complementary information. SSM's overall conclusion here was that SKB's reporting is sufficiently comprehensive and of sufficient quality to justify a continuation to the main review phase.

When reviewing the licence applications, SSM evaluates SKB's choice of method and site to ascertain that the proposed repository system is feasible and can be operated as assumed in SKB's preliminary safety assessment with a high degree of confidence that regulatory requirements on nuclear safety and radiation protection can be fulfilled in the step-wise authorization process that follows a Government licensing decision. Depending on the capacity of SKB to submit

essential complementary information that has been requested for the continued compliance evaluation in the ongoing main review phase, the aim of SSM's current review plan is to submit a final statement to the Swedish Government in early 2016.

A.6.3.2 Low and Intermediate Level Waste (LILW)

These are the main milestones for the remaining LILW programme:
2014 Application for extension of SFR to accommodate decommissioning waste.
2014 Concept study for SFL to be finalized.
2018 Start of construction works for extension of SFR.
2023 Start of operation of extended SFR.
2035 Start of construction works to establish SFL.
2045 Start of operation of SFL.

Repository for short-lived low and intermediate level decommissioning waste (Extended SFR)
SKB plans to dispose of waste from the future decommissioning of the nuclear power plants in an extension to SFR. The planned extension entails an increase of the facility's storage capacity by an estimated 140,000 m^3 from today's capacity of 63,000 m^3, see Figure A13. SKB intends to submit a licence application in 2014 and operation is planned to commence in 2023, see section H.5.2.

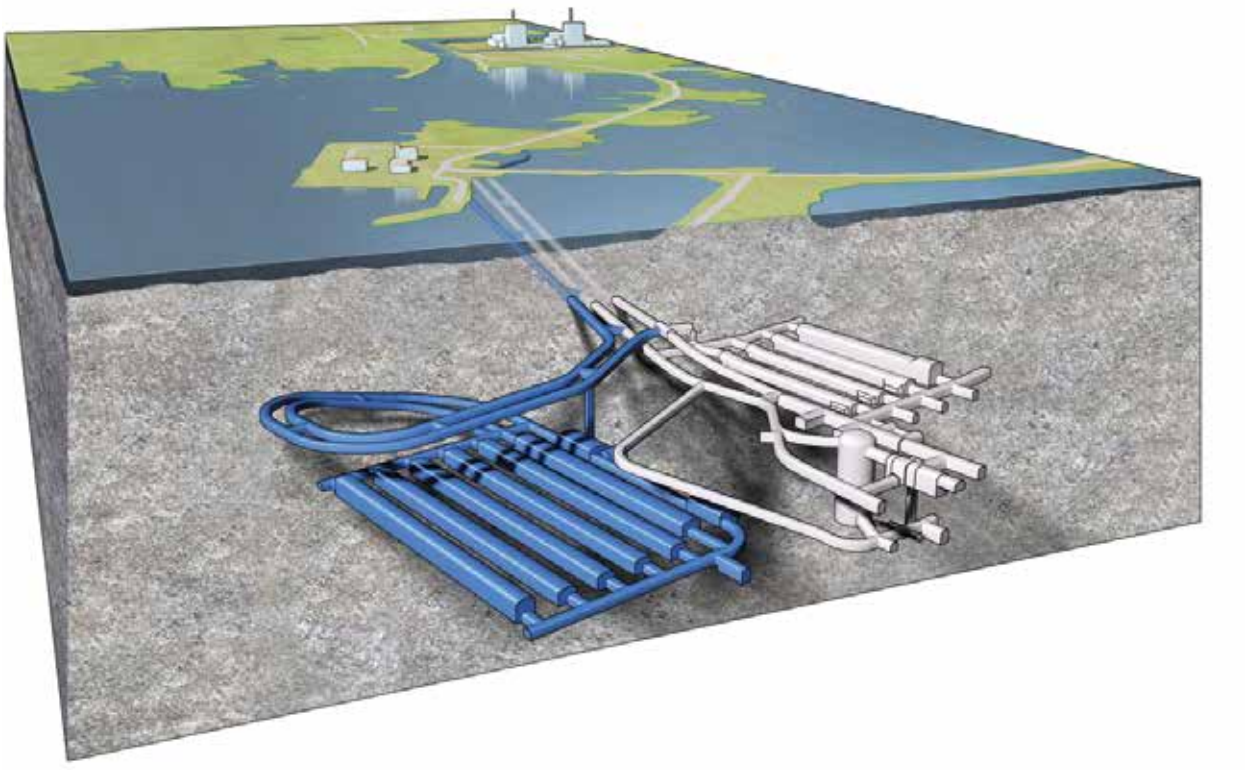

Figure A13: Extended SFR. The existing part is light grey and the planned part is blue.

Repository for long-lived low and intermediate level waste (SFL)
According to the current plans, a licence application to build a repository for long-lived low and intermediate level waste (SFL) will be submitted in 2030 and operation is planned to commence in 2045. The origin of this waste is primarily research, industry, medical applications, core components and certain internal components from nuclear power reactors. The waste is currently stored at Studsvik, the nuclear power plants and Clab. The volume of SFL will be relatively small compared to SKB's other disposal facilities. The total storage volume is estimated at 10,000 m^3.

During the period 2014–2016, the main focus of the work with SFL will be the evaluation of long-term safety that is to be presented in 2016. The purpose of the safety evaluation is to choose a main alternative among proposed repository designs. Moreover, the safety evaluation will develop the set of requirements for the properties of the waste, the engineered barriers and the rock.

It will not be possible to adopt acceptance criteria for conditioned waste destined for SFL until a decision has been made on the repository concept, i.e. not before the safety evaluation is concluded. The nuclear power plants should not commence final conditioning of waste until a verified repository concept exists.

A study will be initiated during the period to plan the site selection process for SFL. Based on the results of the evaluation of long-term safety that is planned for 2016, preliminary requirements on the repository site can be formulated and siting factors identified. In the light of the identified siting factors, contacts can later be made with municipalities where the prospects for a siting are judged to be favourable. Feasibility studies will then be commenced in interested municipalities.

Technology development of the chosen repository concept will commence after the safety evaluation is concluded.

Interim storage of long-lived waste
In the applications for the extension of SFR, SKB will also apply for a licence to interim store long-lived waste in SFR from the nuclear power plants. In the safety analysis report included in the applications, interim storage of long-lived waste will be treated as a part of the activity. The safety risk entailed by storing SFL waste in SFR will be evaluated in a safety assessment. When SFL is put into operation, the interim-stored long-lived waste will be transferred to SFL.

A new transport container, called ATB 1T, has been developed in order to transport the long-lived low and intermediate level waste. Delivery of the container is expected in 2015.

A.7 Swedish participation in international activities to enhance safety and radiation protection

Sweden is a member of the IAEA and the OECD Nuclear Energy Agency (NEA), with permanent delegations to both organisations. Sweden has been a member state of the European Union (EU) since 1995.

Sweden is party to the relevant conventions applicable for a country operating nuclear power plants, encompassing nuclear safety, emergency preparedness and response, nuclear liability, spent nuclear fuel, radioactive waste and physical protection. Sweden has also formally committed to implement the Code of

Conduct on the Safety and Security of Radioactive Sources and the Supplementary Guidance on the Import and Export of Radiation Sources.

A.7.1 The regulatory authority

The regulatory authority's missions and tasks are defined in the Ordinance (SFS 2008:452) with instructions for the Swedish Radiation Safety Authority (SSM). The Ordinance declares that SSM (among other tasks) shall carry out Swedish obligations according to conventions, EU ordinances/directives and other binding agreements (e.g. to provide contact points, reporting, and act as the national competent authority), carry out international cooperation work with national and multinational organisations, and follow and contribute to the progress of international standards and recommendations.

In addition, SSM is involved in international development cooperation within the areas of reactor safety, radiation protection, nuclear waste safety and non-proliferation; see section A.7.2.

SSM has a substantial international cooperation with involvement in about 150 international groups, the majority of which are related to nuclear safety and radiation protection issues. This cooperation takes place within the frameworks of the IAEA, NEA and EU, in connection with international conventions ratified by Sweden and through networks such as the Western European Nuclear Regulators' Association (WENRA), the Heads of European Radiation Control Authorities (HERCA), and the International Nuclear Regulators' Association (INRA).

IAEA safety standards form the main basis for SSM's regulatory requirements and guides. As a member of the European Union, Sweden is obliged to comply with the directives and legal requirements emanating from the Euratom Treaty. SSM has a key role in the transposition of Euratom directives into Swedish legislation. SSM is represented in the IAEA safety standards committees (CSS, NUSSC, WASSC, RASSC and TRANSSC) and takes an active part in the development of new international safety standards for the protection against harmful effects of ionising radiation, e.g. in the development of the IAEA BSS and in the recent revision of the European Basic Safety Standards (BSS) directive (2013/59/EURATOM).

SSM is a member of ENSREG (European Nuclear Safety Regulators' Group), an expert body of senior officials from national regulatory or nuclear safety authorities from all EU member states. Through ENSREG and its working groups, SSM has been active in the recent overview of the directive on establishing a Community framework for the nuclear safety of nuclear installations (2009/71/EURATOM) and in developing implementation and reporting guidelines for the directive on establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (2011/70/EURATOM).

SSM has contributed significantly to WENRA's work on harmonising safety approaches between European member countries. The development of common safety reference levels for radioactive waste storage facilities and for decommissioning has been finalized and work is currently ongoing for geological disposal facilities.

SSM also contributes to the work performed within the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) and the Helsinki Commission (HELCOM) conventions for reduction of releases of radioactive substances from nuclear facilities.

In addition to multilateral collaboration, SSM has bilateral agreements with ten countries to exchange information and to cooperate on agreed issues (e.g. nuclear safety, emergency preparedness, occupational exposure, environmental radiological protection and radioactive waste management). These countries are Canada, Germany, Japan, Lithuania, Ukraine, Russia, France, Finland, the United Kingdom and the United States. Additionally, Sweden has special agreements with the Nordic countries (Denmark, Finland, Iceland and Norway) regarding emergency preparedness and information exchange on the technical design of nuclear facilities.

SSM also has close bilateral technical cooperation with several regulatory authorities, e.g. with STUK in Finland, ASN in France and BfS in Germany on geological disposal of spent fuel and with NDA and ONR in the UK on decommissioning.

SSM also actively participates in international research, primarily in the frameworks of the EU research programmes, but also the IAEA and OECD/NEA. One particular example is SITEX, an FP7 Euratom project bringing together authorities performing technical and scientific assessment of geological disposals.

SSM provides experts to international peer review missions, for instance IAEA review service teams such as OSART, SALTO and IRRS. During the period 2012-2013, Sweden participated in four OSART missions, two SALTO missions and two IRRS missions.

In 2012, SSM received a full scope IAEA IRRS mission to Sweden, as commissioned by the Swedish Government. A follow-up is planned for 2016. In addition, an international team organised by NEA reviewed the post-closure safety case in the licence application submitted by SKB in 2011 for a spent fuel repository. The peer review has been a valuable contribution to SSM's licensing review process as an independent international assessment on the maturity of SKB's programme and to determine if it is on a par with global state-of-the-art and good practices.

SSM's international engagement and work need to be continually reviewed with respect to available staff resources and as part of upholding competent regulatory supervision of licensees and activities in Sweden. In order to support priority decisions, a classification scheme and a policy for international work have been implemented as part of SSM's integrated and process-based management system.

A.7.2 SSM's international support programmes

Since 1992, Swedish authorities have been engaged in providing assistance to states of the former Soviet Union in the areas of nuclear safety and security as well as radiation protection. This work has been carried out by the Swedish Radiation Safety Authority, SSM, since 2008.

The aims of the bilateral assistance are to:

- improve reactor safety and minimise the risk of a nuclear accident with uncontrolled radioactive releases at the facilities in question;
- improve conditions so that radioactive waste, including spent nuclear fuel, shall be handled and stored in a manner that is acceptable from the point of view of safety and radiation protection, regarding personnel, the public and the environment;

- impede the mismanagement of nuclear and radioactive materials and to strengthen the non-proliferation measures and institutions;
- improve the national preparedness and awareness as far as concerns radiation protection for people and the environment;
- strengthen the legislation and exercising of authority in connection with nuclear facilities and handling of radioactive waste; and
- contribute to the development and strengthening of the countries' authorities and organisations within the national emergency preparedness and to establish cooperation in the event of an emergency situation in the Baltic region.

Currently the cooperation partners for Sweden are: Russia, Ukraine, Moldova and Georgia. Previously, Sweden had similar cooperation programmes with Armenia, Kazakhstan, Belarus, Estonia, Latvia and Lithuania. In 2013, the funding allocated by the Swedish Government for these purposes amounted to 5 million euros.

A.7.3 Licence holders

A.7.3.1 General information

The utilities in Sweden have a tradition of being quite active in international cooperation to enhance nuclear safety by sharing experience, contributing to work on international regulations and guidelines and participating in safety assessments and peer reviews.

Swedish fuel cycle facility licence holders such as Studsvik Nuclear AB and Westinghouse Electric Sweden AB are global companies offering a wide range of advanced technical services to the international nuclear power industry in areas including waste treatment, consultancy services and fuel and materials products and technology. Also, representatives from e.g. SKB (see section A7.3.2), AB SVAFO and Barsebäck Kraft AB take an active part in international working groups on waste management and decommissioning. Several international meetings and workshops have been held in Sweden over the past years with support from these organisations and with associated study visits at the facilities.

A.7.3.2 SKB

SKB gives international cooperation high priority and works together with corresponding organisations in Canada, Finland, France, Germany, Japan, Spain, Switzerland, the United Kingdom and the United States.

The main aim of SKB's international activities is to monitor the research and development work conducted in other countries and to participate in international projects within the field of nuclear waste management. Furthermore, this international work provides perspectives to the domestic programme and contributes to maintaining state-of-the-art competence in relevant scientific areas.

SKB participates actively in several IAEA, EU and OECD/NEA committees and working groups. SKB is also engaged in a large number of research projects within these international organisations. From 2009 to 2012, SKB also ran the Secretariat of the "Implementing Geological Disposal of Radioactive Waste Technology Platform" (IGD-TP) in which twelve waste management organisations cooperate. The IGD-TP identifies and prioritizes research and technology development initiatives that are necessary and time-critical for ensuring that the

first geological repositories in Europe will be in operation by 2025. The IGD-TP has no financial resources at its disposal but has an indirect influence on how the EU's research funding is allocated within the area.

The IGD-TP supports a number of prioritized areas, ranging from large joint EU-funded technology development projects, such as DOPAS (plugs in repository tunnels) and research projects such as BELBAR (bentonite stability and buffer erosion) to joint task forces and expert networks. SKB's reason for being active on the platform is that it provides a common platform for scientific cooperation and communication throughout Europe.

SKB is currently participating in the 7th Framework Programme and has actively proposed areas for future research and development in the 8th Framework Programme (Horizon 2020).

The cooperation with Posiva in Finland is the most extensive and comprises projects in the fields of repository technology, site investigation and encapsulation techniques.

An important example of SKB's international research cooperation is the Äspö Hard Rock Laboratory, where organisations from Finland, France, Germany, Japan, Spain, Switzerland, Canada and the Czech Republic are (or have been) carrying out joint studies.

A.7.4 International peer review missions

A brief account of recently conducted international peer review missions in the Swedish nuclear waste management programme is provided below. General information about policy and plans in this regard is provided in section K.6.

A.7.4.1 International peer review of the licence application for a spent nuclear fuel repository

As part of the licensing review, the Swedish Government commissioned OECD's Nuclear Energy Agency, NEA, to organise an international peer review of the post-closure safety report, SR-Site, supporting SKB's licence application for a spent nuclear fuel repository. The remit of the peer review was to provide an independent assessment of the maturity of SKB's post-closure safety case and to determine if it is on a par with international state-of-the-art. The NEA selected a team of ten international experts taking into account SSM's impartiality requirements and general requests for areas of competences to be represented.

The overall conclusion of the peer review was that SKB's post-closure safety report is sufficient and credible for the decision at hand and that SKB generally gives a convincing illustration and technical basis both for the feasibility of the future repository, according to the KBS-3 design, and for its radiological long-term safety. However, the team of experts also gave a number of recommendations for additional research and improvements that are needed for the safety cases supporting the next licensing steps. The team also underscored that the progression from the conceptual phase of SKB's repository project to an implementation phase means that the industrial feasibility of the barriers and of the repository, including assurance of their quality, will become increasingly important. The final review report (available at SSM's website, *www.ssm.se*) was presented to SSM and other stakeholders at a meeting held in Stockholm and at a meeting held in June 2012 open to the public in the municipality proposed for the siting of the spent fuel repository.

A.7.4.2 IRRS missions

Between 6 and 17 February 2012, an international group of experts performed a review of Sweden's compliance with IAEA standards in the form of a full scope IRRS (Integrated Regulatory Review Service) in the fields of nuclear safety and radiation protection. The review was carried out in the following areas:

- responsibilities and functions of the government,
- the global nuclear safety regime,
- responsibilities and functions of the regulatory body,
- the management system of the regulatory body,
- the activities of the regulatory body including the authorization, review and assessment, inspection and enforcement processes,
- development and content of regulations and guides,
- emergency preparedness and response,
- occupational radiation protection,
- environmental monitoring,
- control of radioactive discharges and materials for clearance,
- control of chronic exposure and remediation, and
- waste management, control of medical exposure and transport.

The mission also included a policy discussion on supervisory strategies, the competence at SSM and response to the TEPCO-Fukushima Daiichi accident. Security, non-proliferation and non-ionising radiation issues were not included in the review (a separate international physical protection advisory service, IPPAS, was carried out in 2011).

The review addressed all facilities and activities regulated by SSM including the ten nuclear power units, the fuel fabrication facility, spent fuel and waste management facilities and users of radioactive sources.

The review mission was requested in 2009 on the initiative of SSM and as assigned by the Swedish Government. The peer review was organised by the IAEA and conducted by 18 selected experts from 15 countries as well as six designated experts from the IAEA. Prior to the review mission, SSM conducted a self-assessment on how the Swedish system and regulatory authority fulfil the IAEA's requirements and standards. The self-assessment included responding to a number of questions compiled by the IAEA and was one of several forms of input used by the IRRS team in preparing for the review.

The review demonstrated that the Swedish system for nuclear safety and radiation protection is stable and well-developed, with an independent supervisory authority that is open and transparent, learns from experience and is open to feedback. The IRRS review team identified a number of good practices and made recommendations and suggestions where improvements will enhance the effectiveness of the regulatory framework and functions in line with the IAEA Safety Standards. For example, SSM was recommended to increase its number of compliance inspections and also conduct unannounced inspections. SSM should also develop a consistent and more comprehensive set of regulations and general advice.

Recommendations that were directed towards the Swedish Government included measures to maintain national competence in the fields of nuclear safety and radiation protection, to increase SSM's resources for regulatory supervision and licensing reviews and to establish an ongoing process that keeps the legislation up to date.

Areas underlined by the IAEA's review team as 'good practices' for instance applied to SSM's work to modernise nuclear facilities through measures to improve safety, the disposal of spent nuclear fuel and the Authority's approach to openness and transparency.

As far as concerns SSM's regulatory supervision, the review team established that the inspection activities largely focus on licensee management systems and their use in practice by interviewing personnel at different levels of the facilities' organisations and in different functions. The team also established that SSM performs few unannounced compliance inspections. SSM was recommended to consider performing more unannounced compliance inspections and inspections in more areas, while also observing activities and performing technical inspections more frequently.

The peer review team established that the IAEA's safety standards were being used as a basis for Swedish nuclear safety regulations, or the regulations did refer to them, but not in a systematic way. The team recommended that SSM revise its present regulations to make them clearer, more consistent and comprehensive.

It emerged from both SSM's self-assessment and the IRRS review that the Authority's management system needs to be developed further in different respects. SSM needs to develop more specific guidance on how to pursue work on various review and inspection tasks. These processes and written routines should also be communicated to applicants, licensees and other interested parties. The peer review team also recommended SSM to consider introducing formal competence requirements and compulsory training programmes for all personnel with supervisory tasks.

The review team had only a few comments directly related to SSM's regulations and guidelines concerning geological disposal of spent nuclear fuel and radioactive waste. It was noted that requirements are not fully clear on operational activities in the safety case, testing and monitoring during the operational phase and institutional controls after permanent closure. Sweden's regulatory framework for high-level waste disposal was recognized as being comprehensive and technically sound. The licensing of a disposal for spent nuclear fuel as well as the Authority's approach to openness and transparency were credited as good practices.

Based on the self-assessment and the IRRS team's recommendations, SSM produced an action plan for its development work. A compulsory training programme for all personnel with supervisory tasks has been initiated and is operational, a risk-based approach to long term strategic planning of SSM's supervisory activities is under development and a major revision of SSM's regulatory framework has been initiated.

In 2014, an IRRS follow-up of the Authority's development work was requested by the Swedish Government through SSM. The follow-up is planned for 2016.

A.7.4.3 World Association of Nuclear Operators (WANO)

WANO's mission is "to maximise the safe and reliable operation of nuclear power plants worldwide by working together to assess, benchmark and improve performance through mutual support, exchange of information and emulation of best practices". WANO has programmes within the areas of operating experience, peer reviews and performance indicators and arranges seminars and workshops for its members.

In 2011 SKB became a member of WANO. SKB is actively taking part in all WANO programmes and participates in seminars and workshops.

SKB asked WANO to carry out a review of SKB as a licensee of Clab and SFR, and in the autumn of 2013 an international team of 15 peers visited SKB for three weeks. The result was some areas of improvement, for which measures have now been taken that will ultimately improve the facilities' operational safety.

A.8 The European spallation source research facility

In 2012, the Swedish-based company European Spallation Source ESS AB (ESS) submitted its licence application for construction of the ESS research facility in southwest Sweden. ESS is an intergovernmental research project in which 17 European countries currently are engaged with the aim of constructing and operating a new neutron source based on a large accelerator that bombards a heavy target material (tungsten) with protons. The neutron source makes it possible to study materials in their smallest components. According to the current plan, the ESS facility should be operational in 2025 and it is envisaged that the facility will be in operation for about 40 years.

The ESS facility is not a nuclear facility, but it will house considerable quantities of radioactive material on a par with a research reactor. Thus, significant volumes of radioactive waste will be generated at the facility. The highest level of radioactivity will be generated in the tungsten target, but also to a lesser extent elsewhere, such as activation of the soil filling material surrounding the accelerator. The Swedish Radiation Safety Authority and the Swedish Land and Environmental Court have reviewed the application. On 12 June 2014 the Land and Environmental Court approved the ESS application. The approval was, however, conditional and ESS is not allowed to produce any radioactive waste or start the accelerator until the company has reported on further investigations concerning some radiation protection issues and the management of radioactive waste. The results of the investigations, including a proposal for final licensing conditions, must be reported to the court by 1 July 2017.

The Swedish Radiation Safety Authority decided on 17 July 2014 to grant ESS authorisation to begin construction of the ESS research facility in Lund. Further permission will be required from the Authority before this facility may be commissioned. The Authority has now granted the company a licence to commence construction of the facility. This means that ESS is allowed to import, acquire and own technical devices and other components for generation of ionising radiation. The licence is linked to a number of special conditions for the ESS facility in areas such as physical protection, emergency preparedness work and management of radioactive waste. One of several challenges that ESS faces in the continuing licensing process with the Authority is to clarify and verify that the waste management can be conducted in a way that is safe in terms of radiation safety and radiation protection, and that it can be performed in compliance with applicable regulatory requirements.

B.1 Article 32.1: REPORTING

1. In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each of the obligations of the Convention. For each Contracting Party the report shall also address its:
(i) spent fuel management policy;
(ii) spent fuel management practices;
(iii) radioactive waste management policy;
(iv) radioactive waste management practices; and
(v) criteria used to define and categorize radioactive waste.

B.1.1 Spent fuel and radioactive waste management policy

The rationales for the management system for spent fuel and radioactive waste are established on the platform of basic principles derived from extensive discussions that took place in the Swedish parliament (Riksdag) during the 1980s and 1990s. The Swedish parliament has supported four basic principles for the management of spent nuclear fuel and nuclear waste (bill 1980/81:90, Appendix 1, p. 319, bill 1983/84:60, p. 38, bill 1997/98:145, p. 381, bill 1992/93:98, p. 29 as well as the final reports of the Standing Committee on Industry and Trade, 1988/89:NU31 and 1989/90:NU24).

The national policy and strategy for the management system for spent fuel and nuclear waste are based on the following four basic principles:

1. Costs for the treatment and disposal of spent fuel and radioactive waste from nuclear activities shall be covered by fees that licensees are required to pay.
2. The licensees are to safely dispose of spent nuclear fuel and radioactive waste from nuclear activities.
3. The state has the ultimate responsibility for spent nuclear fuel and radioactive waste from nuclear activities.
4. Each country is to be responsible for the spent nuclear fuel and radioactive waste generated from nuclear activities in that country. The disposal of spent nuclear fuel and nuclear waste from nuclear activities in a foreign country is not allowed in Sweden other than in exceptional cases.

Another basic prerequisite as regards spent fuel management is that reprocessing will not take place, although this is not prohibited. Thus, spent nuclear fuel is in practice both considered as and treated as waste, although it is not legally defined as waste until disposed of in a repository.

A governmental inquiry has suggested that the state's ultimate responsibilities should be regulated by law. The proposal is currently under consideration by the Government. After a repository has been closed, a requirement should be imposed to ensure that some kind of responsibility for and supervision of the repository can be established and maintained for a considerable time. A government authority could assume responsibility for a closed repository.

As mentioned in the fourth national report, the former ban on constructing new nuclear power reactors in Sweden has been lifted. Since then, in 2012, Vattenfall AB applied to replace up to two of its existing reactors with new ones. It is thus far unclear whether and when new nuclear power reactors can become a reality, but it is necessary for both the industry and government to be prepared for the probability of an expanded nuclear programme and the impact that this will have on Sweden's future policy for spent fuel and radioactive waste management.

In view of the plans for expanded nuclear power, it is important to emphasize the following. A basic requirement under both the Act on Nuclear Activities and the Environmental Code is that before an operation is authorized, the applicant must show how the waste from that operation will be taken care of and disposed of. When the operation has been started, detailed plans for waste disposal are also to be reported in the RD&D programmes required under the Act on Nuclear Activities, see section E.2.2.1.

B.1.2 Spent fuel management practices

At the nuclear power plants, the spent nuclear fuel is stored in fuel pools for at least nine months before it is transported to the central interim storage facility for spent nuclear fuel (Clab). The safety and security measures taken at the NPPs do not differentiate between spent or partially spent fuel. The process of loading spent fuel into transport containers (weight: 80 tonnes, thickness: 32 cm of steel, length: 6.15 m, diameter: 1.95 m, capacity: 17 BWR elements or 7 PWR elements) is closely monitored and carefully performed in order to guarantee a contamination-free surface on the container. Special procedures are rigorously followed to achieve the desired quality control. Spent nuclear fuel from the Forsmark NPP and the Ringhals NPP (and previously the Barsebäck NPP) is transported using specially designed transport vehicles to the site harbours and shipped to the central storage facility for spent nuclear fuel in Oskarshamn. Spent nuclear fuel from the Oskarshamn NPP is transported directly to Clab by means of specially designed transport vehicles.

SSM supervises the management of spent nuclear fuel at the NPPs during ordinary inspections of safety and security, including transports to Clab. These procedures fall under the general management of safety.

The capacity of Clab was increased in 2008. Its storage capacity is now sufficient to provide for storage of all spent fuel to be produced by Swedish NPPs up to about 2023, i.e. 50 years of operation of the reactors Ringhals 1 and 2 and 60 years of operation of the Ringhals 3 and 4 reactors and the reactors in Oskarshamn and Forsmark.

According to the current plans, following a storage period in Clab of about 30-40 years, fuel elements will be transported to the spent nuclear fuel repository. Prior to this, they will be placed in a cast iron insert in a copper canister. In the repository, they will be surrounded by a buffer of bentonite clay and deposited in individual vertical boreholes in crystalline bedrock at a depth of 400-700 m. SKB, as well as all other waste programmes internationally, have chosen a geological repository as the preferred solution to ensure the long-term safety of disposed spent fuel or high level radioactive waste.

The siting process for the repository ended in June 2009, when the board of SKB decided to choose Forsmark as the site for the repository for spent nuclear fuel; see sections A.6.3.1 and G.3.2.2. In March 2011, SKB submitted a licence application for siting and construction of the repository, which is expected to commence operation in 2029.

B.1.3 Radioactive waste management policy

For radioactive waste management policy, the same four basic principles apply as for spent nuclear fuel (see section B 1.1).

B.1.4 Radioactive waste management practices

Very low level short-lived waste (VLLW) may be:

- disposed of in shallow land burials that are licensed under the Act on Nuclear Activities; or
- subject to clearance according to the regulatory authority's requirements and decisions, and either:
- be released for unrestricted use;
- disposed of in municipal landfills; or
- incinerated using specific furnaces (only applicable to contaminated oil).

Short-lived LILW is treated and packaged according to a standardized system with predefined waste type descriptions (WTD) and disposed of in the repository for operational waste (SFR), in rock caverns in crystalline bedrock at a depth of about 30-50 m. WTDs are subject to approval by the regulatory authority. The repository consists of five different caverns. Wastes are directed to different parts of the repository depending on factors such as the activity content and chemical characteristics.

Long-lived LILW will be disposed of in a repository situated in rock caverns in crystalline bedrock. Until the repository has been constructed, the long-lived waste will be stored either at the NPP, at the Studsvik site or in storage pools in the interim storage facility for spent nuclear fuel (Clab). However, SKB is investigating the possibility of establishing an interim storage facility for long-lived low and intermediate level waste in the planned extension of SFR. A decision regarding interim storage in SFR will be taken before the design of the extension has been established.

Waste arising outside of the nuclear fuel cycle may–when needed and if appropriate–be disposed of in disposal facilities for nuclear fuel cycle wastes.

B.1.5 Criteria for defining and categorising radioactive waste

B.1.5.1 Definitions

The definition of nuclear waste according to the Act on Nuclear Activities (1984:3) is:

- spent nuclear fuel that has been placed in a repository,
- radioactive material that has been generated in a nuclear facility and that has not been produced at or taken from the facility to be used for educational or research purposes or for medical, agricultural engineering or commercial purposes,
- material or item that has belonged to a nuclear facility and become contaminated by radioactivity and which shall no longer be used in such facility, and
- radioactive parts of a nuclear facility that is being decommissioned.

In the Radiation Protection Act (1988:220) the term 'radioactive waste' is used. The term includes radioactive waste from nuclear activities as well as from non-nuclear activities (medical use, use of sealed sources, research institutions,

consumer products, etc.). The legal definitions are discussed further in section E.2.1.2, and section D, in which the disposal routes for different waste streams are presented.

B.1.5.2 Categorisation

There is no legally defined waste classification scheme in Sweden for nuclear or radioactive waste. There is, however, an established waste classification scheme used by the nuclear industry in Sweden. The classification scheme used in Sweden was derived from existing and future repositories (end points), see Table B1.

	Cleared material	**Very low level waste short-lived (VLLW-SL)**	**Low level waste short-lived (LLW-SL)**	**Intermediate level waste short-lived (ILW-SL)**	**Low and intermediate long-lived waste (LILW-LL)**	**High level waste (HLW)**
Definition	Material with so small amounts of radioactive nuclides that it has been released from regulatory control.	Contains small amounts of short-lived nuclides with a half-life shorter than 31 years; dose rate on waste package is shorter than 0.5 mSv/h. Long-lived nuclides with a half-life longer than 31 years can be present in restricted quantities.	Contains small amounts of short-lived nuclides with a half-life shorter than 31 years; dose rate on waste package (and unshielded waste) is shorter than 2 mSv/h. Long-lived nuclides with a half-life longer than 31 years can be present in restricted quantities.	Contains significant amounts of short-lived nuclides with a half-life shorter than 31 years; dose rate on waste package is shorter than 500 mSv/h. Long-lived nuclides with a half-life longer than 31 years can be present in restricted quantities.	Contains significant amounts of long-lived nuclides with a half-life longer than 31 years, past the restricted quantities for short-lived waste.	(Nuclear fuel) Typical decay heat >2kW/m^3 and contains significant amounts of long-lived nuclides with a half-life longer than 31 years, past the restricted quantities for short-lived waste.
Other demands	-	-	-	Demands radiation shielding during transport.	Demands special containment during transport.	Demands cooling and radiation shielding during intermediate storage and transport.
Destination	No final repository needed.	Shallow land burial.	Final repository for short-lived radioactive waste (SFR).	Final repository for short-lived radioactive waste (SFR).	Final repository for long-lived radioactive waste (SFL).	Final repository for spent fuel.

Table B1: Waste classification scheme used by the nuclear industry in Sweden.

An important task when comparing wastes from different countries is to have them classified according to an unanimously used scheme. If this is not the case, waste data must be converted from the national classification scheme to a common scheme, preferably the waste classification scheme proposed by the IAEA. The waste classification scheme used by the industry in Sweden would be converted to the scheme used by the IAEA (GSG-1) according to the matrix below, see Table B2.

IAEA Distribution (%)				
Sweden	**VLLW**	**LLW**	**ILW**	**HLW**
VLLW-SL	100			
LLW-SL		100		
ILW-SL		100		
LILW-LL			100	
HLW				100

Table B2: Comparison between the Swedish classification scheme and IAEA definition.

The choice to allow the long-lived waste, even if its activity content is low, to be represented as intermediate, follows the IAEA Safety Standards Series No. GSG-1.

Before disposal is allowed, a separate permit from the regulatory authority is needed for each category of waste. The permit is based on a waste type description (WTD) comprising detailed specifications on waste treatment, composition and conditioning, etc. Furthermore, for each subsystem, such as the different rock caverns of the SFR facility, dose rate criteria have been established. In addition, total dose and/or nuclide specific activity limits have also been established for the disposal facility as a whole and for each section of the facility.

Thus, a tailor-made management system for the production and disposal of waste packages has been developed. Waste categorisation is strictly operational and depends on the origin of the waste and of the disposal facilities. Waste packages are produced according to detailed specifications in the WTDs. These are developed in close cooperation between the waste producer (the NPPs) and the repository licensee (SKB). Treatment and conditioning at the NPPs are governed by the management systems at the NPPs and subject to the general regulations and requirements for quality assurance. This is also the case for handling and disposal at SFR. All documentation concerning a single waste package is saved locally in databases at the NPPs. Basic information concerning a package needs to be transferred to a waste database at the repository before a waste package may be transported to SFR. The system checks the incoming information to ensure that criteria from the WTDs are fulfilled and that the package is suitable for emplacing in the predestined part of the repository. After transport to SFR, all documentation is transferred to the database for long-term recordkeeping.

C.1 Article 3: SCOPE OF APPLICATION

- This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.
- This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.
- This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.

C.1.1 Reprocessing and military or defence programmes

Reprocessing is not part of the nuclear fuel cycle in Sweden. There is no reprocessing facility in Sweden and spent fuel from nuclear power reactors is not sent for reprocessing in other countries. Reprocessing agreements were concluded with the former company United Kingdom Atomic Energy Agency in 1969 and Compagnie générale des matières nucléaires (COGEMA) for reprocessing of spent nuclear fuel from civilian nuclear power plants. Only a small number of fuel elements were in fact shipped for reprocessing and the agreements were terminated in the early 1980s. These past practices are also discussed in section D.1.1.

Sweden terminated all research activities related to military or defence programmes in 1970, and all radioactive residues from activities involving nuclear technology are since then part of the civilian sector. Radioactive waste from research activities related to military or defence programmes prior to 1970 has been permanently transferred to the management programme for civilian radioactive waste.

Sweden declares all spent fuel and all radioactive waste originating from the nuclear fuel cycle for the purpose of the Joint Convention pursuant to Article 3, paragraphs 1 and 3.

C.1.2 Naturally occurring radioactive materials

Sweden does not declare waste that contains only naturally occurring radioactive material and that does not originate from the nuclear fuel cycle as radioactive waste for the purpose of the Joint Convention pursuant to Article 3, paragraph 2.

D.1 Article 32.2: REPORTING

1. This report shall also include:
(i) a list of the spent fuel management facilities subject to this Convention, their location, main purpose and essential features;
(ii) an inventory of spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;
(iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;
(iv) an inventory of radioactive waste that is subject to this Convention that:
(a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;
(b) has been disposed of; or
(c) has resulted from past practices.
This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides;
(v) a list of nuclear facilities in the process of being decommissioned and the status of decommissioning activities at those facilities.

D.1.1 Management of spent nuclear fuel

Spent nuclear fuel from the NPPs is temporarily stored in fuel pools before being transported to the central interim storage facility for spent nuclear fuel (Clab), where it will be stored for at least 30 years before being encapsulated and deposited in a disposal facility.

Most spent nuclear fuel in Sweden emanates from commercial nuclear power plants at the Forsmark, Oskarshamn and Ringhals sites, but also from the Barsebäck site, which was permanently shut down on May 31, 2005. Small amounts of spent nuclear fuel originate from the research reactors at Studsvik (which were permanently shut down on June 15, 2005). In addition, some spent nuclear fuel from the decommissioned research reactor R1 and from the closed Ågesta reactor must be managed.

Spent nuclear fuel elements from the closed research reactors R2 and R2-0 in Studsvik have been exported to the United States in accordance with the contract agreements.

All remaining spent fuel from the Ågesta district heating power reactor has been transferred to Clab. Spent fuel from the R1 research reactor consists of rods of metallic uranium enclosed in an aluminium alloy casing. This type of fuel is

not suitable for disposal in accordance with the KBS-3 method. Since the closure of the R1 reactor it has been temporarily stored at the Studsvik site. In 2007 the intact parts of the fuel were separated from corroded parts, in the form of powder and lumps, and transported to the United Kingdom for reprocessing. The resulting fissile material, 1.2 kg of plutonium, was stored at Sellafield and the remaining waste from the reprocessing was sent back to Sweden in 2009. This waste is being temporarily stored at the Studsvik site prior to transport to a disposal facility. In 2014 the ownership of the plutonium was transferred to the UK Nuclear Decommissioning Authority.

The corroded parts of the R1 fuel are still being temporarily stored at the Studsvik site prior to transport to a disposal facility. The remnants of the R1 fuel consist of coarse pieces of corroded metallic uranium. The material has been placed in a special type of canister allowing controlled gaseous exchange. The material will probably be reconditioned before being sent for disposal in the planned facility for long-lived waste (SFL).

No spent nuclear fuel is currently being disposed of in Sweden.

D.1.2 Spent nuclear fuel facilities and inventories

D.1.2.1 Interim storage at the nuclear power plants

Each NPP unit has a fuel pool close to the reactor vessel in which spent fuel is stored temporarily for at least nine months before being transported to Clab, see Figure D1. The fuel pools constitute integrated parts of the reactor facilities and are for the purpose of the Joint Convention not considered to be separate spent fuel management facilities. The amount of spent fuel stored in pools at the nuclear power reactors as at 31 December 2013 is presented in Table D1. The pool capacity listed corresponds to the storage capacity for spent fuel. The pools also have space for the plundered reactor core, fresh fuel, scrap and boxes.

Fuel pool at NPP	Pool capacity	Spent nuclear fuel stored as at 31 Dec. 2013	
	(no. of fuel assembly positions)	(no. of assemblies)	(tonnes*)
Oskarshamn 1	969	81	13
Oskarshamn 2	1,052	602	101
Oskarshamn 3	1,040	303	50
Forsmark 1	1,392	290	48
Forsmark 2	1,268	370	62
Forsmark 3	1,040	342	57
Ringhals 1	1,426	218	36
Ringhals 2	432	140	61
Ringhals 3	381	161	70
Ringhals 4	364	133	58

*uranium weight

Table D1: Inventory of spent fuel in NPP pools.

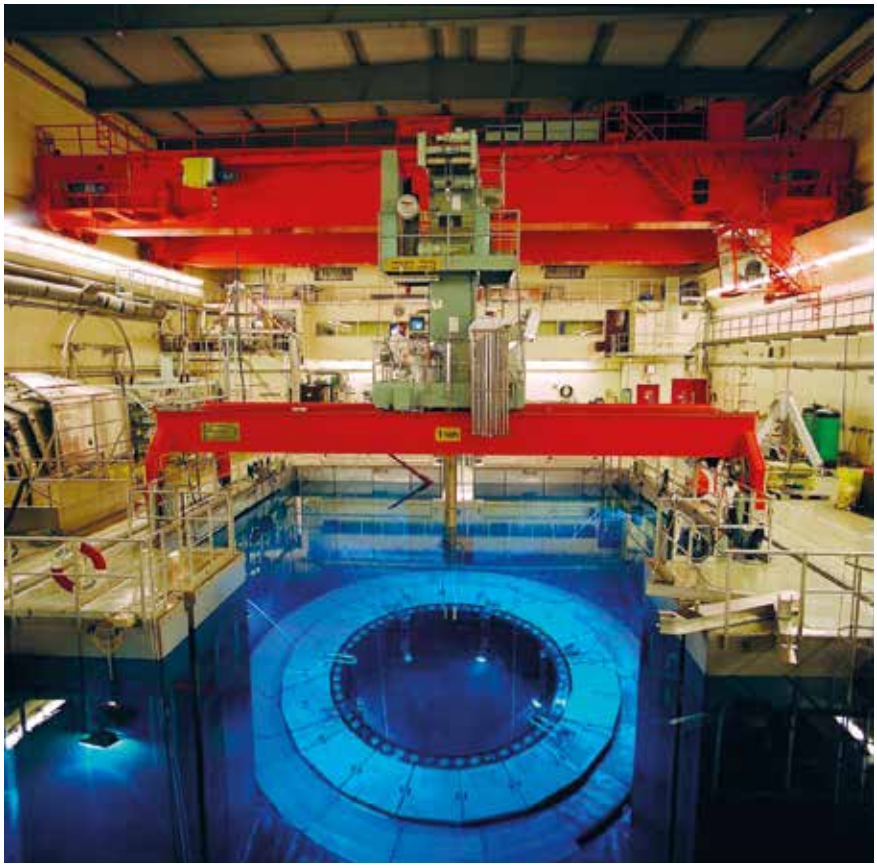

Figure D1: Reactor top and pools at one of the Swedish reactors.

D.1.2.2 Spent nuclear fuel facilities and inventories at Studsvik

As described in section D.1.1, remaining waste from the reprocessing of the intact parts of the R1 fuel is temporarily stored on site at Studsvik before transport to a disposal facility, see Table D2.

Spent nuclear fuel in storage as at 31 Dec. 2013		
Origin	**No. of assemblies**	**kg**
R1	1	40

Table D2: Spent fuel from the research reactor R1 temporarily stored at Studsvik.

D.1.2.3 Clab, the central interim storage facility for spent nuclear fuel

Spent fuel assemblies are to be stored at the Clab facility for at least 30 years. The main reason is to allow the thermal output to decay by about 90% before encapsulation and disposal. Other highly radioactive components such as control rods from reactors are also stored in Clab awaiting disposal. A drawing of Clab is shown in Figure D2.

After being removed from the cask in an unloading pool, the spent fuel assemblies are transferred to storage canisters for subsequent transport and storage. A water-filled elevator cage takes the storage canister down to the storage section where it is placed in a predetermined position in a storage pool. Thus, unloading and all subsequent handling of spent fuel assemblies are performed underwater using hydraulic machines. The water, which circulates in a closed system, acts both as a coolant and as an effective radiation shield, and no additional radiation protection equipment is needed. The water is circulated through filters to keep it clean before being returned to the pools. The heat is removed in heat exchangers, cooled by seawater in an intermediate cooling system. All safety systems have backups. Vital parts of the monitoring and control systems can be powered by a battery backup system. The storage pools are designed to withstand seismic loads as well as extreme temperature loads in the event the cooling systems should fail.

As a follow-up to the severe Fukushima Daiichi accident, the Clab facility was analysed (stress tests) due to requirements specified by the European Nuclear Safety Regulators Group, ENSREG. The aim was to assess the robustness of the facility's beyond design basis. SKB's stress test analysis of Clab indicated that the facility is robust and able to withstand the events it is designed for as well as having adequate margins in many of the situations analysed. The analysis also identified a number of areas for improvement regarding the facility's resilience and ability to withstand extreme events, see section K.1.4.

Approximately 100 people work at the facility; one-third of them with day-to-day operation and the others with radiation protection, chemical sampling, maintenance and repairs. The number of fuel assemblies of different types stored at the Clab facility and corresponding tonnages are listed in Table D3 below.

Specification	**Spent nuclear fuel stored as at 31 Dec. 2013**	
	(no. of assemblies)	**(tonnes)**
BWR fuel	25 525	4 317
PWR fuel	3 197	1 378
Fuel from Ågesta district heating nuclear power reactor	222	20.2
Fuel from Studsvik	20	2.4
German MOX-fuel (exchanged for Swedish fuel reprocessed in France)	217	22.5
Total	**29 181**	**5 740**
Storage capacity		8 000

Table D3: Inventory of spent fuel stored in Clab as at 31 Dec. 2013.

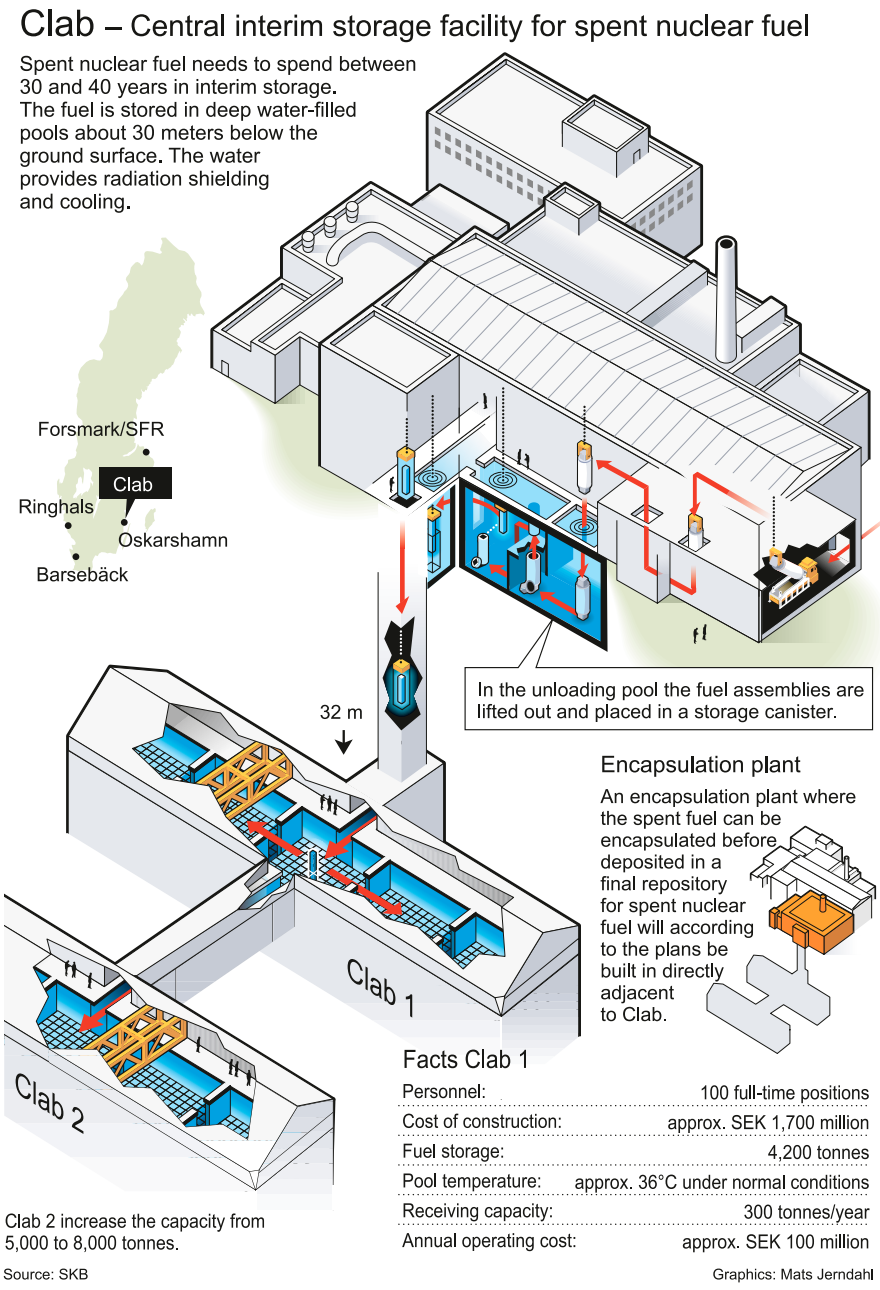

Figure D2: The Clab facility.

D.1.3 Management of radioactive waste at the nuclear power plants

Waste management at the NPP sites is fully integrated into the operations at each site. Fulfilment of the requirements of SSM's general regulation is accomplished and verified through regulatory review and inspection activities at the nuclear power plants, as reported in the Swedish reports under the Convention on Nuclear

Safety. Temporary storage of radioactive waste at the nuclear power plant sites is in practice an integrated part of the site.

Waste with very low activity (VLLW) is disposed of in shallow land burials on site, with the exception of Barsebäck, which disposes of VLLW in SFR.

Short-lived low and intermediate level waste (LILW) from the nuclear power plants consists of ion exchange resins from filters, metal scrap, pipes, valves, pumps, tools and protective clothing. The waste is classified and handled initially on site in preparation for disposal. The purpose of the waste handling at the power plants is to reduce its volume, to solidify wet waste in concrete or bitumen and to pack the waste in suitable packages. Four types of standardised packages (steel drums, steel and concrete moulds and steel containers) are used, as well as standard ISO containers. Waste packages are placed temporarily in storage on the site before being transported to the repository for operational waste, SFR.

The waste is treated differently at the different nuclear power plants. Table D4 below illustrates the methods used and packages for operational waste produced at the nuclear power plants.

Type of waste	Ringhals	Barsebäck	Oskarshamn	Forsmark
Ion exchange resins	Solidified in concrete, packed in concrete modules and steel moulds.	Solidified in concrete and packed in steel drums. Dewatered and packed in concrete tanks.	Solidified in concrete and packed in concrete drums. Dewatered and packed in concrete tanks.	Solidified in bitumen and packed in steel moulds. Dewatered and packed in concrete tanks.
Metal scrap and residues	Cast in concrete and packed in concrete moulds. Packed in standard ISO containers.	Packed in standard ISO containers.	Cast in concrete and packed in concrete moulds.	Packed in steel moulds. Packed in standard ISO containers.
Sludges	Solidified in concrete, packed in concrete moulds.			

Table D4. Waste treatment methods at the NPPs (no more operational waste is currently produced at the Barsebäck site following the closure of this plant).

D.1.4 Radioactive waste facilities and inventories

D.1.4.1 Radioactive waste treatment facilities and inventories at NPP sites

At the OKG site, the interim storage facility for low and intermediate level waste is placed in a rock cavern. At the other nuclear power plants' sites, there are special buildings for interim storage of conditioned operational waste on the site. Safety reports have been drawn up for all facilities where radioactive waste is handled and stored. The safety reports describe the facility and the waste handling activities, the content of radioactive substances, supervisory activities and include a safety

analysis. As waste packages from the NPP sites are transported to SFR on a regular basis, it is not relevant for the purpose of the Joint Convention to present a list of the inventories for the interim storage at the sites.

D.1.4.2 Radioactive waste management facilities at Studsvik Nuclear AB

The Studsvik facilities are located in southern Sweden about 30 km outside Nyköping. See aerial view in Figure D3.

Hot cell laboratory, HCL
The Hot Cell Laboratory is primarily used to investigate irradiated nuclear fuel, although it is also used for studies of other types of irradiated materials. In addition, the laboratory is used for the conditioning, treatment and encapsulation of spent fuel fragments in packages suitable for interim storage in other facilities. The laboratory has seven cells with thick concrete walls, and lead windows to protect the personnel from ionising radiation. All waste is removed from the laboratory after conditioning.

The active metal laboratory, AKL
The Active Metal Laboratory is primarily used to investigate irradiated metallic materials. The laboratory has several cells with lead walls to protect the personnel from ionising radiation. All waste is removed from the laboratory after conditioning.

The incineration facility, HA
The facility is used for incineration or pyrolysis of low-level waste (LLW) from NPPs, fuel fabrication plants, hospitals, research institutions and facilities in Studsvik. The activities also comprise management, radiological measurement and final conditioning of the waste. Ashes are stabilized in concrete for disposal or, if the waste comes from overseas, returned to the origin for further management. The current licence permits the treatment of 600 tonnes of combustible waste annually.

The melting facility, SMA
The melting facility in Studsvik is used for volume reduction of contaminated metal. After melting and radiological measurement, the material may be exempted from regulatory control or returned to the source for further management. The current licence permits the treatment of 5,000 tonnes of metal annually.

The storage facility, FA
This facility, which contains three water pools, was built in 1965 for the interim storage of spent nuclear fuel from the Ågesta reactor. As all fuel from Ågesta has been transferred to Clab, the facility may be used for other purposes such as storage of spent fuel from other reactors, or for storage of other radioactive materials. Today the pools are used for storage, examination and demounting of pins of spent AGR (Advanced Gascooled Reactor) fuel prior to examinations performed in HCL. The AGR fuel is returned to the UK following examinations.

Treatment facilities for radioactive non-nuclear waste, FR0-A and R0-A
Disused sealed sources and radioactive waste from medical use, research and industry are mainly managed in the two facilities FR0-A and R0-A. In R0-A ionising smoke detectors are dismantled, whereas all other disused sealed sources

and radioactive waste are treated in FR0-A. Depending on activities, dose rate, material, etc., treatment comprises sorting, volume reduction, packing and conditioning. Some of the disused sealed sources and radioactive waste may also be treated in the facilities HA, SMA or HM.

Monitoring at Studsvik's facilities
Whenever there is a risk of airborne emissions, ventilation and/or exhaust systems are monitored for any radioactive substances. Likewise, to avoid contamination from waste water, common drainage systems are monitored for any radioactive substances before the water is released to the recipient.

Figure D3: The facilities at Studsvik.

D.1.4.3 Radioactive waste management facilities at AB SVAFO

The following are the most important facilities operated by AB SVAFO at the Studsvik site.

Treatment facility for intermediate waste, HM
This facility is used for the treatment of intermediate solid and liquid waste from facilities at Studsvik. Treatment of solid waste comprises sorting, volume reduction (compaction), packing and conditioning by means of stabilization with concrete. Treatment of liquid waste comprises sedimentation and solidification by means of stabilization with concrete.

Interim storage facility for low and intermediate level waste, AM
The AM facility was constructed in the 1980s for the interim storage of conditioned waste from facilities at the Studsvik site. The storage facility is constructed in a

cavern in bedrock with a rock cover of at least 20 metres. The rock mass is grouted with concrete, the walls are reinforced by means of rendering concrete and special arrangements have been made to drain the rock. The storage facility is dimensioned to receive waste until about the year 2045. The storage area is divided into two parts: one part is used for waste that requires shielding and the other is used for waste not requiring shielding. The shielded part of the AM storage facility has a capacity of about 4,000 m^3, corresponding to 1,632 moulds and 1,020 four-drum unit trays; the unshielded part has a capacity of about 1,120 m^3, corresponding to 660 moulds and 264 four-drum unit trays. A further 1,000 drums can be deposited in other parts of the storage facility. The waste is conditioned and packed in special containers before being positioned in the store. The ventilation and drainage systems are monitored for any radioactive substances.

The following types of waste originating from the Studsvik facilities are currently being stored at AM, see also Table D5:
- operational waste from the R2 research reactor and the tests performed in the reactor,
- irradiated and contaminated material from the production of isotopes,
- irradiated and contaminated material from the fuel testing laboratory, and
- start sources from an old research reactor and operational waste from the waste handling facilities.

These are the externally produced types of waste currently being stored at AM:
- residual products from incinerated waste from nuclear power plants, hospitals and industry,
- residual products from the use of isotopes in industry and hospitals,
- decommissioning waste from old nuclear facilities, and
- waste from treatment of steam generators from Ringhals.

Number of packages	Volume (m^3)*	Mass (tonnes)*	Activity (Bq)
2,685	2,089	3,862	6,40E15

*including packaging

Table D5: Inventory of disposed radioactive waste in AM as at 31 Dec. 2013.

Storage facility for radioactive waste, AU
The AU facility is an interim storage facility for long-lived low level waste that has been conditioned. It is a simple unheated building made of concrete and steel. The AU storage facility contains drums with historical waste embedded in concrete. The waste was reconditioned in the 1990s. About 7,000 drums were previously stored in the facility. The waste will ultimately be disposed of in the planned disposal facility for long-lived waste.

Monitoring at SVAFO's facilities HM and AM
The ventilation systems are monitored for any radioactive substances. The drainage water is also cleaned and monitored for any radioactive substances before the water is released to the recipient.

Export of plutonium
Since the 1970s, 3.3 kg of plutonium from former research and development

activities in Sweden has been securely stored in a special vault in the R2 facility at Studsvik under IAEA safeguards. During 2012 this material was stabilized, repacked and exported to the US under the U.S. Global Threat Reduction Initiative (GTRI), a non-proliferation programme with the aim of securing sensitive nuclear material. Sweden received guarantees on the end use of the exported material, which means that it may only be used for peaceful purposes and not exported further in accordance with US commitments in the area of nuclear non-proliferation.

D.1.4.4 Repository for short-lived low and intermediate level waste (SFR)

General information

The capacity of SFR is approximately 63,000 m^3. By 31 Dec. 2013, 33,871 m^3 of waste had been disposed of. In the safety assessment, the total radioactivity of the waste in the filled repository is assumed to be 10^{16} Bq.

The repository is designed to isolate the waste from the biosphere in order to avoid harmful consequences for people and the environment both during operation and after closure. This is accomplished by emplacement in rock under the seabed and by the technical barriers surrounding the waste, see Figure D4.

SFR consists of the silo, the rock vault for intermediate level waste (BMA), two rock vaults for concrete tanks (1BTF, 2BTF) and the rock vault for low level waste (BLA). The storage vaults are located in the bedrock approximately 60 m below the seabed, 1 km from the shore. The underground part of the repository is accessed through two tunnels.

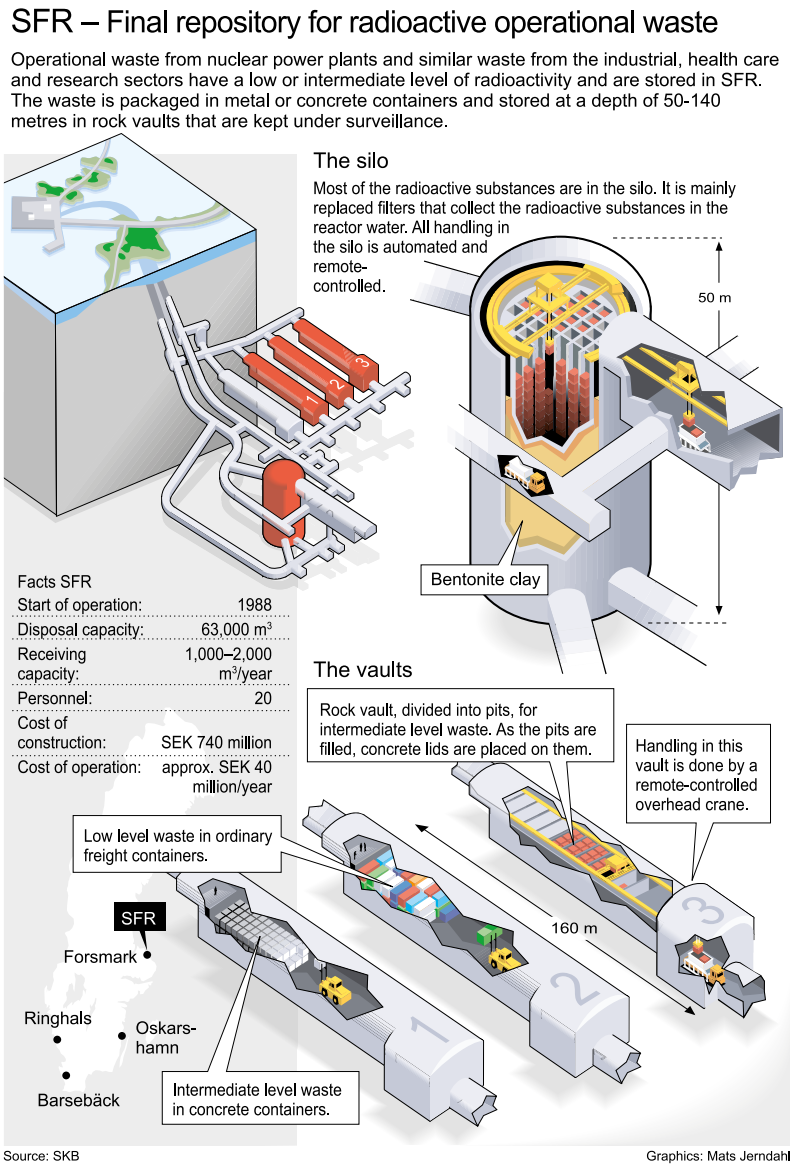

Figure D4: The SFR facility

The Silo
The main part of the radioactivity in the waste designated for SFR is intended for disposal in the silo. This waste comes from many different waste streams, but the most important one comprises ion exchange resins in a concrete or bitumen matrix from the nuclear power plants. Other waste like metal components of different origins is also disposed of in the silo. The amount of organic material is kept to a minimum. The maximum surface dose rate permitted on a package is 500 mSv/h. All handling of waste packages is performed using remote control equipment. The dominant nuclides are Co-60 and Cs-137.

The silo consists of a cylindrical concrete construction with shafts of different sizes for waste packages. The concrete cylinder is approximately 50 m high with a diameter of approximately 30 m. The largest shafts measure 2.5 m by 2.5 m. The waste packages are placed in the shafts, normally in layers of four moulds or 16 drums. The spaces between the waste packages are gradually backfilled with porous concrete. The walls of the silo are made of 0.8 m thick reinforced concrete. In between the walls and the surrounding rock, there is a bentonite backfill averaging 1.2 m thick. The 1 m thick concrete floor at the bottom of the silo is placed on a layer of 90/10 sand/bentonite mixture.

According to the present plans, a 1 m thick concrete lid will cover the top of the silo. After closure, the lid will be covered with a thin layer of sand, a 1.5 m thick layer of sand/bentonite mixture (90/10), and the remaining space will be filled with sand, gravel or sand stabilized with cement.

The rock vault for intermediate level waste (BMA)
The radioactivity in the waste that is disposed of in BMA is generally lower than in the waste in the silo. The waste in BMA comes from many different waste streams. The most important one is ion exchange resins from the nuclear power plants. Other waste such as metal components of various origins as well as contaminated rubbish are also disposed of in BMA.

The maximum dose rate permitted on packages is 100 mSv/h, and the radionuclide content is fairly low. BMA has been designed to handle approximately 6% of the radionuclides in SFR. The dominant nuclides are Co-60 and Cs-137. The waste packages are of the same type as in the silo, i.e. moulds and drums.

The rock vault is approximately 160 m long, 19.5 m wide with a height of 16.5 m. Inside the cavern a concrete construction has been raised so that the vault is divided into 15 compartments. The moulds and drums are placed in the compartments using remote-controlled equipment.

The waste is piled on top of the concrete floor in such a way that the concrete moulds act as support for prefabricated concrete slabs, put in position as soon as the compartments are filled. It is also possible to backfill the void between the waste packages in a compartment. Lastly, a layer of concrete will be cast on top of the lid. Between the concrete structure and the rock wall there is a 2 m wide space, which will be filled with sand before closure. The space above the concrete structure may be left unfilled, but it could also be backfilled. Plugs will be placed in the two entrances to the vault when the repository is closed.

The rock vaults for concrete tanks (BTF)
There are two rock vaults in SFR for concrete tanks: 1BTF and 2BTF. The waste in 1BTF mainly consists of drums containing ash and concrete tanks containing

ion exchange resins and filter parts, whereas the waste in 2BTF consists of only the latter. Moreover, some large components of metal, e.g. steam separators or reactor vessel lids, may be disposed of in the caverns.

The maximum dose rate permitted on packages is 10 mSv/h. The radionuclide content is fairly low, and the dominant nuclides are Co-60 and Cs-137. The rock vaults are approximately 160 m long, 14.8 m wide with a height of 9.5 m. The concrete tanks, each 10 m^3 in volume, are stacked in two levels with four tanks in each row. A concrete radiation protection lid is placed on top of the stacks. The space between the different tanks is backfilled with concrete and the space between the tanks and the rock wall will be filled with, for example, sand stabilized with cement.

The rock vault for low level waste (BLA)

The waste that is disposed of in BLA, short-lived waste, is mainly low level scrap metal (iron/steel, aluminium), cellulose (e.g. wood, textile, paper), other organic materials (e.g. plastics, cables) and other waste such as insulation (e.g. rock wool) packed in standard steel containers.

The maximum dose rate permitted on the surface of the waste packages is 2 mSv/h. The radionuclide levels are low, and the dominant nuclide is Co-60. Some of the waste inside the containers is placed in steel drums and others in bales.

The rock vault cavern is approximately 160 m long, 15 m wide with a height of 12.5 m. The design is very simple: there is basically only a concrete floor on which containers are placed. During the operational phase a ceiling has been placed above the waste in order to minimize water dripping onto the waste. This inner roof will be dismantled before the repository is closed.

The containers are piled three high in rows of two. Most of the containers are half height, allowing six to a pile. No backfilling is planned.

Principal data, see Table D6 and inventories, see Table D7 are listed below. The nuclide specific activity content can be seen in Figure D5.

Principal data for SFR	
Owner and licence holder:	Swedish Nuclear Fuel and Waste Management Co (SKB)
Operation and maintenance:	SKB
Start of construction:	1983
Start of operation:	1988
Number of staff:	Approximately 40
Storage capacity:	63,000 m^3
Silo	Short-lived LILW, max dose rate 500 mSv/h
BMA	Short-lived LILW, max dose rate 100 mSv/h
1 BTF	Short-lived LILW, max dose rate 10 mSv/h
2 BTF	Short-lived LILW, max dose rate 10 mSv/h
BLA	Short-lived LILW, max dose rate 2 mSv/h
Disposal capacity	6,000 m^3/year
Current disposal rate	100 – 600 m^3/year

Table D6: Principle data for SFR.

Waste disposed of in SFR as at 31 Dec. 2012		
Repository section	**Volume (m³)**	**Activity (Bq)***
Silo	5,768	5,1E14
BMA	9,371	2,5E14
1 BTF	2,304	1,9E12
2 BTF	7,310	1,5E13
BLA	10,200	4,8E11
SFR total	34,953	7,8E14

*Activity values per 31 Dec. 2012

Table D7: Inventories of radioactive waste disposed of in SFR as at 31 Dec. 2012.

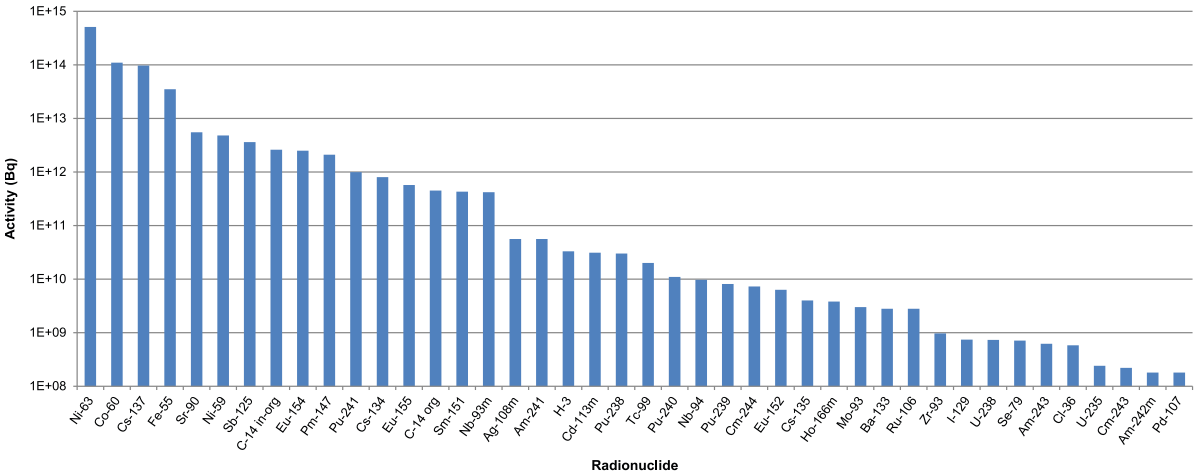

Figure D5: Radionuclide specific activity content in SFR. The numbers are for the situation as at 31 December 2012.

D.1.4.5 Shallow land burial

Like other nuclear installations, shallow land burials are licensed under both the Act on Nuclear Activities (SFS 1984:3) and the Environmental Code (SFS 1998:808). For further information regarding the licensing process, see section E.2.3.1. In the Ordinance on Nuclear Activities (SFS 1984:14), SSM is given a mandate to license nuclear installations, such as shallow land burials, up to a specified inventory limit; licences above this limit are issued by the Government. The highest level according to the Ordinance is 10 TBq, of which a maximum of 10 GBq may consist of alpha-active substances.

SSM may issue conditions under the Radiation Protection Act (1988:220) or the Act on Nuclear Activities (1984:3). For shallow land burials, no approval by the Government is needed before the Land and Environmental Court can issue a licence, including licence conditions, according to the Environmental Code.

The nuclear power plants at Ringhals, Forsmark and Oskarshamn as well as the Studsvik site have shallow land burial facilities for very low-level waste. The total activity content is according to the licence limited to 100-1100 GBq per facility.

When licensing the shallow land burial facilities, one criterion is that the releases of radionuclides from the facilities shall not contribute significantly to the releases from the pre-existing nuclear facilities at the site.

In addition to regulating the total activity content, waste acceptance criteria specify the nuclide specific activity concentration and the surface dose rate of the individual packages. The activity concentration is specified to the point in time in the future when the shallow land burial is planned to be released from a radiation protection point of view. The specified time for the different shallow land burials is shown in Table D8. In older licence conditions, the total activity concentration at the time of disposal was limited to 300 kBq/kg for radionuclides with a half-life longer than 5 years.

Waste is disposed of in campaigns at 3-5 year intervals. The facilities are closed in between the campaigns. The design and layout of the shallow land burial facilities differ but all facilities have a top sealing layer to reduce the infiltration of water, see Figures D6 and D7. The design of the top sealing layer differs between the facilities: bentonite liners, plastic membranes and massive layers of glacial clay or mixes of bentonite and sand have been used, as well as mixed designs. The sealing layer of the facilities is covered with a drainage layer and, on top of that, a protective layer of e.g. soil, approximately 1 metre thick. At the newer installations in Ringhals and Oskarshamn, a geological barrier has been installed down-gradient of the disposal facility. At the repositories in Forsmark and Studsvik, a natural or semi-natural geological barrier reduces leakages to the environment. There are monitoring programmes for sampling leachate water, for example with respect to radionuclides.

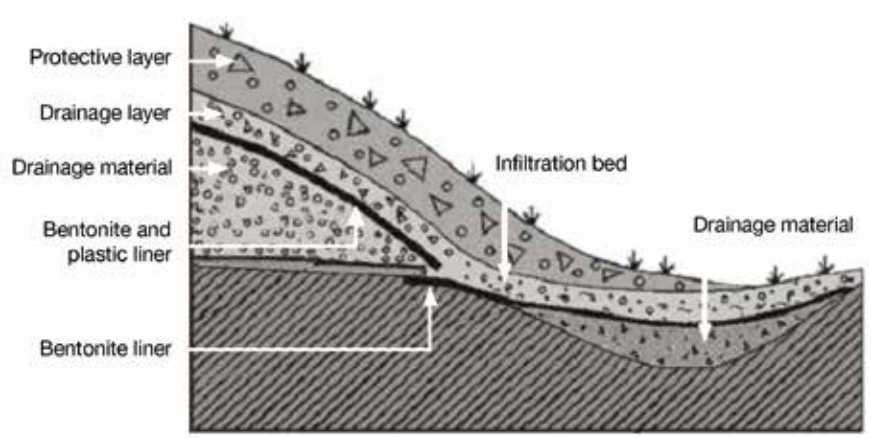

Figure D6: Principle section of shallow land burial at OKG.

The waste disposed of at the three nuclear power plants consists of low-level scrap and refuse from the operations of the NPPs. The waste consists of piping, tools, insulation material and protective clothing as well as rubbish such as plastics, paper and cables, etc. The dominant nuclides are generally Co-60, Cs-137 and Ni-63. The shallow land burial at Studsvik, where also waste from the decommissioning of various old nuclear installations and operational waste from the Studsvik facilities has been disposed of, has a somewhat different composition.

Figure D7: The shallow land burial at OKG.

	Licence conditions			Waste disposed of as at 31 Dec. 2013		
Site	**Licence period***	**Volume (m^3)**	**Max activity/max alpha activity (GBq)**	**Mass (tonnes)**	**Volume (m^3)**	**Activity (GBq)**
Forsmark	2070	17 000	200/0.2	3 415	5 231	24,3
Oskarshamn	2075	10 000	200/0.2	3 769	7 346	19,1
Ringhals	2060	10 000	1100/0.1	3 640	5 942	181*
Studsvik (SVAFO)	2040	1 540	100/0.1	1 151	1 140	39**

The licence period includes a 30-year surveillance period (50 years for OKG) during which no further disposal of waste is allowed.

* Valid 19 Aug. 2004 and no new waste has been disposed of.
** The licence for further disposition has not been renewed by SSM. The licence volume cannot therefore be used to its full extent. The activity was valid 31 Dec 2004.

Table D8: Inventories of waste disposed of in shallow land burials.

D.1.4.6 Waste from fuel fabrication

Westinghouse Electric Sweden AB operates a factory in Västerås for the fabrication of nuclear fuel. This is located approximately 100 km west of Stockholm. The factory has been manufacturing fuel since the mid-1960s. Its annual production

is approximately 500–600 tonnes of UO_2 fuel for PWRs and BWRs, mainly for customers abroad.

The manufacturing process generates some slightly uranium-contaminated waste in the form of CaF_2, metal, construction waste, electronics, combustible wastes, sludge, filters, protective clothing, etc. Westinghouse disposes of waste with very low uranium content, typically CaF_2, metal and construction wastes at municipal landfills as permitted by the Swedish Radiation Safety Authority. Most of the uranium in the waste is however first extracted through special recovery processes in the Västerås plant. Also, a new facility for waste processing (pyrolysis) at Studsvik Nuclear AB has been developed. Burnable waste from Westinghouse is currently processed in that facility. A minor part of the remaining waste can be considered for future storage in a disposal facility.

Section E – LEGISLATIVE AND REGULATORY SYSTEM

This section is divided into three parts. The first part, E.2.1, presents basic prerequisites for the legal and regulatory framework. The second part, E.2.2, contains basic information concerning definitions within the Swedish legislative system and presents an overview of the relevant acts. The third part, E.2.3, describes the implementation of the requirements in regulatory review activities. Special emphasis is placed on the licensing system, prohibition, institutional control, regulatory inspection, documentation and reporting, enforcement of regulations and terms of a licence, and a description of the allocation of responsibilities of the bodies involved.

Since the last review meeting, the following changes have occurred in the legislation of importance for the legal and regulatory infrastructure:

- SSM has received a Government assignment to prepare new regulations in order to develop well adapted and updated requirements for new nuclear power reactors. In connection with the task of developing new regulations, SSM is revising other regulations of the Authority governing ionising radiation.
- By means of an amendment made on May 8, 2013 to the Ordinance on Supervision under the Environmental Code, SSM is required to provide regulatory guidance concerning supervision of pollution damage and other environmental damage caused by radioactive substances. This mandate enables SSM to give stronger assistance to other regulatory authorities as part of supervising the cleanup of sites contaminated by radioactive substances.
- The 2011 proposal on merging the provisions of the Act on Nuclear Activities and the Radiation Protection Act with the Environmental Code, as suggested by a Committee of Inquiry and reported on in the previous national report, is still under consideration by the Government.
- SSM received a Government assignment in 2014 to investigate and propose necessary changes to the legislation due to the Council Directive 2013/59/EURATOM (BSS). The assignment is to be completed by January 1, 2016.
- In 2012, SSM submitted a proposal to the Government on implementation of Council Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.
- In November 2011, SSM decided on revised regulations and general advice concerning clearance of materials, rooms, buildings and land in practices involving ionising radiation (SSMFS 2011:2).
- In November 2011, SSM decided to amend the Regulations concerning Safety in Nuclear Facilities (SSMFS 2008:1) with requirements regarding e.g. the handling of nuclear material and nuclear waste, disposal plans, register for nuclear waste, decommissioning plans, etc. These requirements are not new but are incorporated from previously approved regulations, namely SSMFS 2008:19 and SSMFS 2008:22, which therefore ceased to apply.
- In December 2011, SSM decided on new regulations and general advice on naturally occurring radioactive material (SSMFS 2011:4).
- In April 2012, SSM decided on revised regulations on ash contaminated with caesium or uranium (SSMFS 2011:4).
- By means of an amendment made in August 2013 to the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452), SSM is required to submit proposals to the Government regarding the appropriate time for the evaluations and international audits that should be performed

at least every ten years in accordance with Article 9.3 of Council Directive 2009/71/Euratom and Article 14.3 of Council Directive 2011/70/Euratom. The Authority must also report the results of the assessments and audits conducted and propose measures to address the outcome.

- SSM shall be the contact point referred to in Article 5.1 of the Convention on the Physical Protection of Nuclear Material.
- SSM shall ensure that there is a present national plan for the management of nuclear material that is not intended to be reused, as well as for nuclear and other radioactive waste. The plan is to contain the statement required under Article 12 of Council Directive 2011/70/Euratom. In the process of developing or amending the plan, SSM should give appropriate representatives of the relevant agencies, local authorities, the public and industry an opportunity to comment. SSM shall keep the Commission informed of the national plan and all significant changes made in it. SSM shall also provide the Commission with the information requested by the Commission under Article 13 of Council Directive 2011/70/Euratom.
- SSM shall, with neighbouring countries, pursue development and collaboration with community functions and organisations in the countries in which the Government decides, and pursue other international cooperation in the same societal functions in other countries (mainly Eastern Europe and the Russian Federation) and with international organisations.

E.1 Article 18: 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 Joint Convention are discussed in this report.

E.2 Article 19: LEGISLATIVE AND REGULATORY FRAMEWORK

> 1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management.
>
> 2. This legislative and regulatory framework shall provide for:
>   (i) the establishment of applicable national safety requirements and regulations for radiation safety;
>   (ii) a system of licensing of spent fuel and radioactive waste management activities;
>   (iii) a system of prohibition of the operation of a spent fuel or radioactive waste management facility without a licence;
>   (iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;
>   (v) the enforcement of applicable regulations and of the terms of the licences;
>   (vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.
>
> 3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.

E.2.1 Basic prerequisites for the legal and regulatory framework

E.2.1.1 Fundamental principles for the management of spent fuel and radioactive waste

In section B.1.1 the basic principles that apply to spent fuel and radioactive waste, and the background of these principles, are described. In brief, the principles specify the following:

1. Costs for the treatment and disposal of spent fuel and radioactive waste from nuclear activities shall be covered by fees that licensees are required to pay.
2. The licensees are to safely dispose of spent nuclear fuel and radioactive waste from nuclear activities.[5]
3. The state has the ultimate responsibility for spent nuclear fuel and radioactive waste from nuclear activities.
4. Each country is to be responsible for the spent nuclear fuel and radioactive waste generated from nuclear activities in that country.

The first principle is stated in the Financing Act, and the second and fourth principles in the Act on Nuclear Activities (sections 10–12 and 5 a). As far as concerns the third principle, the Government has in a statement accepted by the Parliament declared that the State has the ultimate responsibility for operations as a consequence of the provisions of the Act on Nuclear Activities, also in the very long term.

E.2.1.2 Nuclear and radioactive waste

In the Act on Nuclear Activities, radioactive waste produced by nuclear activities is defined as "nuclear waste". The precise definition according to the Act is presented in the next section.

In the Radiation Protection Act, the term "radioactive waste" is used. The term includes radioactive waste from nuclear activities as well as from non-nuclear activities (medical use, use of sealed sources, research institutions, consumer products, etc.).

E.2.2 Legislative framework

Figure E1 illustrates the basic characteristics of the Swedish legislative system. The Parliament adopts acts, which usually contain basic requirements and the mandate to the Government or the authority appointed by the Government to issue more detailed requirements. If the Government wishes to transfer regulatory powers to an authority, this is done in the form of an Ordinance. Regulations are often the basis for supervision as they specify in more detail the level of requirements.

As reported below, SSM has a mandate to issue regulations concerning radiation safety according to the Act on Nuclear Activities and the Radiation Protection Act on the basis of Government Ordinances.

[5] *Swedish law uses the term "nuclear waste" which is not consistent with international terminology. This report therefore uses the term "radioactive waste from nuclear activities" in order to make a distinction between waste from the nuclear fuel cycle and radioactive waste from other activities.*

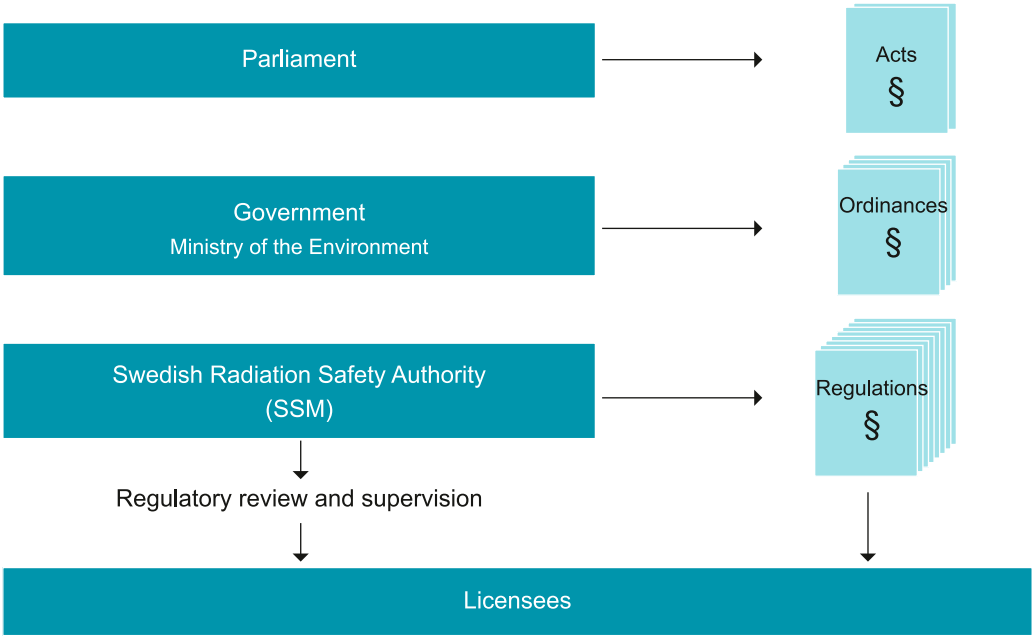

Figure E1: Overview of the Swedish legislative system.

The framework of Sweden's legislation in the fields of waste management, nuclear safety and radiation protection is to be found in the form of five Acts with associated Ordinances:

- Act on Nuclear Activities.
- Radiation Protection Act.
- Environmental Code.
- Act on Financial Measures for the Management of Residual Products from Nuclear Activities.
- Parts of the Act on the Control of Dual-use Items and Technical Assistance.

E.2.2.1 The Act and Ordinance on nuclear activities

The Act on Nuclear Activities is the basic law regulating nuclear safety. It contains basic provisions concerning safety in connection with nuclear activities, and applies to the handling of nuclear material and nuclear waste as well as to the operation of nuclear power plants.

The Swedish Parliament has on several occasions declared that Sweden supports and will follow the principle of the responsibility of each country to take care of and dispose of spent fuel and radioactive waste produced within the country in question.

Disposal as well as interim storage of foreign spent fuel and nuclear waste in Sweden is prohibited.

A special licence may however be granted by the Government in special cases to allow for very small amounts of foreign spent fuel or radioactive waste to be disposed of in Sweden, provided that it does not impede the R&D programme regarding safe disposal of spent fuel in Sweden.

The Act does not contain provisions concerning radiation protection. This area is regulated in a separate act, the Radiation Protection Act, see section E.2.2.2. As

far as nuclear activities are concerned, the Radiation Protection Act and the Act on Nuclear Activities should be applied in parallel and in close association with each other.

The Ordinance on Nuclear Activities (1984:14) contains detailed provisions on areas such as definitions, applications for licences, reviews, evaluations and inspections.

The Ordinance also specifies that the regulatory authority assigned by the Government (SSM) is authorised to issue permits for transportation of nuclear materials and nuclear waste. The Authority is also authorised to impose licence conditions and to issue general regulations concerning measures to maintain the safety of nuclear activities.

Safety requirements

Nuclear activities shall be conducted so as to meet safety requirements and fulfil the obligations pursuant to Sweden's agreements for the purpose of preventing the proliferation of nuclear weapons and unauthorised dealing with nuclear material and spent nuclear fuel.

Safety in nuclear activities shall be maintained by taking all the measures required to prevent errors in equipment, or its defective function, to prevent incorrect handling or any other circumstances that could result in a radiological accident, and to prevent unlawful dealings with nuclear material or nuclear waste. The Government or the authority appointed by the Government may issue more detailed provisions concerning these areas. As mentioned above, SSM has the mandate to impose detailed regulations.

Definitions

The handling or transport of nuclear waste or other dealings with this waste are defined as a nuclear activity.

The Act defines nuclear waste as:

- spent nuclear fuel that has been placed in a repository,
- radioactive material that has been generated in a nuclear facility and that has not been produced at or taken from the facility to be used for educational or research purposes or for medical, agricultural engineering or commercial purposes,
- material or item that has belonged to a nuclear facility and become contaminated by radioactivity and which shall no longer be used in such facility, and
- radioactive parts of a nuclear facility that is being decommissioned.

General obligations of licensees and licence conditions

The licence holder for a nuclear activity shall be responsible for ensuring that all the measures are taken needed for:

- maintaining safety, with reference to the nature of the activities and the conditions under which they are conducted;
- ensuring the safe handling and disposal of nuclear waste arising from the activity or nuclear material arising therein that is not reused; and
- the safe decommissioning and dismantling of plants in which the nuclear activity no longer will be conducted.

The holder of a licence for a nuclear activity must ensure that all the necessary measures are taken for maintaining safety. These general requirements are supplemented by more detailed regulations issued by SSM (see below) and, if needed, licence conditions that the Authority may issue in individual cases. The licensing conditions are imposed when a licence is issued. Licensing conditions can also be imposed during the period of validity of a licence.

Safe management and disposal of nuclear waste
The holder of a licence for nuclear activities is responsible for the management and disposal of the waste produced and for decommissioning. The holder of a licence for the operation of a nuclear power reactor shall – in cooperation with the other holders of a licence for the operation of nuclear power reactors – establish and carry out an R&D programme for the safe handling and disposal of spent fuel and nuclear waste. Every third year, a report describing the programme shall be submitted to SSM for review. An important step in the review process is that the programme is sent to a large number of stakeholders for consultation and comment, such as other government organisations, municipalities, environmental organisations, research institutions and universities.

Following the review, SSM sends a review statement regarding the R&D programme to the Government. The Government determines whether or not the programme can be approved. In connection with this decision, the Government may issue conditions concerning the content of the nuclear power operator's (through SKB) future research and development work.

Environmental impact assessment and general rules of consideration
Licensing of nuclear activities requires submission of an EIA (Environmental Impact Assessment) in connection with the application. Detailed regulations on how the EIA should be carried out and what it should contain have been issued as part of the Environmental Code. In addition, the applicant must demonstrate compliance with the general rules of consideration contained in the Environmental Code, see section E.2.2.4.

Sanctions
The Act on Nuclear Activities also contains provisions on safeguards, sanctions, etc. Anyone who conducts nuclear activities without a licence, or disregards conditions or regulations, will be sentenced to pay a fine or imprisoned for a maximum of two years. If the crime is intentional and aggravated, the individual shall be sentenced to imprisonment for a minimum of six months and a maximum of four years. Liability shall not be adjudged if responsibility for the offence may be assigned under the Penal Code or the Act on Penalties for Smuggling (2000:1225) or if the offence is trivial.

Regulations on civil liability for radiological damage are contained in the Atomic Liability Act (1968:45). The Act is largely based on the contents of the Paris Convention on Nuclear Third Party Liability from 1960 and the Brussels Supplementary Convention from 1963, to which Sweden has acceded.

Public insight
It is considered crucial to give the general public insight into and information on nuclear activities. In municipalities where major nuclear facilities are located

(power reactors, research reactors and facilities for manufacturing, handling, storage or disposal of nuclear material or nuclear waste), it is particularly important to provide the residents with correct and reliable information. For this purpose, "local safety boards" have been established in the municipalities hosting nuclear power plants.[6]

The licence holder for a major nuclear plant is required to give the local safety board insight into the safety and radiation protection work at the plant. The licence holder must, at the request of the board, provide the board with information on the facts available and give the board opportunities to study relevant documents and give the board access to plants and sites.

The function of these boards is to obtain insight into safety and radiation protection matters and to inform the public about these areas. Consequently, it is important to point out that the board does not have the powers to impose requirements on nuclear plants, or to prescribe safety-enhancing or other measures for these plants. These functions rest exclusively with the regulatory authorities.

Licensing

In principle, all activities involving nuclear material or nuclear waste constitute a nuclear activity for which a licence is required. However, nuclear waste and nuclear material with a very low level of radiation can be released from regulatory control.

Prohibition and revocation

A licence to conduct nuclear activities may be revoked by the authority issuing the permit if:

- conditions have not been complied with in some essential respect;
- the licensee has not fulfilled its obligations concerning research and development work on waste management and decommissioning, and there are very specific reasons from the viewpoint of safety to revoke the licence; or
- there are any other very specific reasons for revocation from the viewpoint of safety.

This means that revocation of a licence may be decided in cases of severe misconduct by the operator or otherwise for exceptional safety reasons. If the licence to operate a nuclear power plant is revoked, the licence holder remains responsible for waste management and decommissioning.

Institutional control, regulatory inspection and documentation and reporting

Institutional control

See section E.2.3.3.

Regulatory inspection

Compliance with the Act on Nuclear Activities and with conditions or regulations imposed pursuant to the Act is supervised by a regulatory body assigned by the Government. This body is SSM. If requested by SSM, a licence holder is required to:

[6] *Kävlinge (Barsebäck NPP), Oskarshamn (Oskarshamn NPP), Nyköping (Studsvik research facility), Varberg (Ringhals NPP) and Östhammar (Forsmark NPP).*

- submit all information and documentation necessary to perform the supervision; and
- provide access to a nuclear installation or site for nuclear activities for investigations and taking of samples to the extent necessary to exercise supervision.

SSM may decide on any measures, conditions and prohibitions necessary in individual cases in order to implement the Act on Nuclear Activities, or regulations or conditions issued as a consequence of the Act, see also section E.2.3.3.

Documentation and reporting
See section E.2.3.3.

Enforcement of regulations and terms of licences
See section E.2.3.4.

Clear allocation of responsibilities
See section E.2.3.5.

E.2.2.2 The Radiation Protection Act and Ordinance

Requirements for radiation protection are set out in the Radiation Protection Act (1988:220) and in the Radiation Protection Ordinance (1988:293). The Act and the Ordinance entered into force in 1988. The purpose of the legislation is to protect people, animals and the environment against the harmful effects of radiation. Persons engaged in activities involving radiation are obliged to take the requisite precautionary measures. They are also responsible for the proper handling and disposal of the radioactive waste produced, which includes covering the costs associated with both the handling and disposal of the waste.

The Ordinance (1988:293) on Radiation Protection contains detailed provisions pursuant to authorisation under the Radiation Protection Act. It stipulates that the regulatory authority assigned by the Government may issue regulations regarding further provisions concerning general obligations, radioactive waste and prohibitions against activities with certain materials, etc. The Ordinance also stipulates that certain provisions in the Act do not apply to very low-level radioactive materials and technical equipment emitting only low-level radiation (exemption). The regulatory authority may also issue regulations concerning the release of very low-level radioactive material.

Radiation protection requirements
Definitions
The Act applies to all activities involving radiation. These are defined to include all activities involving radioactive substances or technical devices capable of generating radiation.

Consequently, the Act applies to radiation from nuclear activities and to harmful radiation, ionising as well as non-ionising, from any other source (medical, industrial, research, consumer products and NORM). As far as nuclear installations are concerned, the Act and the Act on Nuclear Activities are applied in close association with each other.

The Government or the mandated authority may, to the extent it does not conflict with the purpose of the Act, prescribe exemptions in full or in part from the application of the Act. An exemption can also be combined with special conditions. Furthermore, specific conditions can be stipulated on radioactive substances or technical devices capable of generating radiation which are not otherwise covered by the Act.

Basic requirements on radiation protection

Radiation protection work in Sweden is based on the International Radiation Protection Commission's (ICRP) internationally recognised principles. These principles are:

Justification: No activity is to be introduced until it has been shown to provide greater advantages than disadvantages to society. The basic principle of justification with regard to the management of nuclear and non-nuclear radioactive waste cannot be questioned at this stage. The waste has been generated as a result of previous decisions.

Optimisation: All radiation doses to individuals, the number of exposed individuals as well as the probability of receiving doses must be kept as low as reasonably achievable, while taking into account economic and societal factors. This is often called the ALARA principle (As Low As Reasonably Achievable).

Dose limitation: Individual exposure to radiation (dose) must not exceed the established limits for the particular circumstances. The dose limit or dose constraint can be seen as a limit for optimisation; thus, the individual doses must not exceed the established limits, even if the collective dose would be reduced as a result.

The Government or the authority assigned by the Government may also issue further regulations as required for protection against, or control of, radiation in the respects specified in the Act.

General obligations of licensees and licence conditions

Any person who conducts activities involving radiation shall, according to the nature of the activities and the conditions under which they are conducted:

- take the measures and precautions necessary to prevent or counteract injury to people and animals and damage to the environment;
- supervise and maintain the radiation protection at the site, on the premises and in other areas where radiation occurs; and
- correctly maintain the technical devices and the measuring and radiation protection equipment used in the activities.

The provision implies that all the necessary measures should be taken to improve radiation protection; it is not sufficient only to comply with the regulations or conditions issued by the responsible authority.

The Government or the authority assigned by the Government may also issue any further regulations required for protection against, or control of, radiation in the respects specified in the act.

When a licence is, or has been, issued according to the Radiation Protection Act, the responsible authority may impose the conditions needed for radiological protection. Such conditions can also be imposed on activities licensed within the legal framework of the Act on Nuclear Activities.

Safe management and disposal of radioactive waste
Anyone who conducts activities involving radiation is required to treat and, as necessary, dispose of the radioactive waste which may arise in the activity.

Anyone who conducts or has conducted activities using a technical device that can emit radiation shall, to the extent stipulated by the Government or the authority appointed by the Government, ensure that the device is destroyed when it is no longer being used in the activity.

Environmental impact assessment
The Government or an authority appointed by the Government may, in licensing cases, prescribe that the applicant prepares an EIA (Environmental Impact Assessment) before permission is given. Such EIA shall be conducted in accordance with the rules contained in the Environmental Code, see section E.2.2.4.

Sanctions
The Government and the responsible authority decide upon matters regarding licences under the Radiation Protection Act. A licence under this Act may be revoked if specific regulations or conditions have not been complied with in any significant respect, or if there are other very specific reasons.

Liability under the Act is not adjudged if responsibility for the offence may be assigned under the Penal Code or the Act on Penalties for Smuggling (2000:1225). Nor is liability adjudged in the instance of a minor offence deemed to be a trivial case. The police authority shall provide the necessary assistance for supervision.

Public information about radiation protection
One of the Authority's tasks is to inform society about radiation protection issues. In 2004, an education centre was established to offer courses in the area of radiation protection.

Licensing
According to the Radiation Protection Act, a licence is required for the following:

- The manufacture, import, transport, sale, transfer, leasing, acquisition, possession, use, depositing or recycling of radioactive substances.
- The manufacture, import, sale, transfer, leasing, acquisition, possession, use, installation or maintenance of a technical device capable of and intended for emitting ionising radiation, or a part of such device that is of substantial importance from the viewpoint of radiation protection.
- The manufacture, import, sale, transfer, leasing, acquisition, possession, use, installation or maintenance of technical devices, other than those referred to in the previous sub-clause, and which are capable of generating ionising radiation, and for which the Government or the authority appointed by the Government has prescribed a licence requirement.
- The export of radioactive substances if a licence is not granted according to the Act on the Control of Dual-use Items and Technical Assistance (2000:1064).

A licence according to the Radiation Protection Act is not required for activities licensed according to the Act on Nuclear Activities.

Prohibition and revocation
A licence under the Radiation Protection Act may be revoked if regulations or conditions imposed pursuant to the Act have been violated in a significant respect or there are other very strong reasons for revocation. Furthermore, the Government, or the authority appointed by the Government, may issue prohibitions against e.g. the manufacture, sale, acquisition, possession or use of materials containing radioactive substances.

Institutional control, regulatory inspection and documentation and reporting
Institutional control
See section E.2.3.3.

Regulatory inspection
The Government assigns a regulatory body (SSM) to supervise compliance with the Radiation Protection Act and licences and conditions issued under the Act. SSM may decide on all the measures necessary and all the conditions and prohibitions required in individual cases to implement the Act, or regulations or conditions issued as a consequence of the Act, see also section E.2.3.3.

At the request of SSM, any party that conducts activities involving radiation is required to submit the information and provide the documents required for its supervision. SSM should also be given access to the installation or site where the activities are conducted for investigations and sampling to the extent required for supervision of the operation.

Documentation and reporting
See section E.2.3.3.

Enforcement of regulations and terms of licences
See section E.2.3.4.

Clear allocation of responsibilities
See section E.2.3.5.

E.2.2.3 SSM's Regulations on Nuclear Safety and Radiation Protection

With reference to its legal mandate, the Swedish Radiation Safety Authority (SSM) issues legally binding safety and radiation protection regulations for nuclear facilities in its Regulatory Code, SSMFS. SSM has in the SSMFS series reissued all earlier regulations previously issued by SKI and SSI. The following sections address regulations with relevance to safety and radiation protection at nuclear installations, as defined by the Convention.

In addition, SSM issues general advice on interpretation of most of the safety regulations. The general advice is not legally binding per se. Measures should be taken according to the general advice or, alternatively, methods justified to be equivalent from the point of view of safety should be implemented. The regulations and general advice listed below all entered into force on February 1, 2009.

SSM's regulations also implement binding EU legislation and international obligations. As part of preparing SSM's regulations, consideration is given to IAEA safety standards, international recommendations, industrial standards and norms, and the rulemaking of other Swedish authorities. SSM's regulations are

issued in accordance with an established management procedure that stipulates technical and legal reviews of draft versions. In accordance with governmental rules, a review is performed of the final draft by authorities, licensees, various stakeholders and industrial and environmental organisations.

Regulations and General Advice Concerning Safety in Certain Nuclear Facilities (SSMFS 2008:1)

These general regulations are primarily worded to apply to nuclear power reactors, but are in a graded way applicable to all licensed nuclear facilities regardless of the size or type of facility, i.e. research or materials testing reactors, fuel fabrication plants, facilities for handling and storage of spent nuclear fuel and facilities for handling, storage or disposal of nuclear waste. The regulations were amended in November 2011.

The purpose of the regulations is to specify the measures needed for preventing and mitigating radiological accidents, preventing illegal handling of nuclear material and nuclear waste and for conducting efficient supervision. The regulations cover the following areas:

- Application of multiple barriers and defence-in-depth.
- Handling of detected deficiencies in barriers and the defence-in-depth.
- Organisation, management and control of activities significant for safety.
- Actions and resources for maintaining and developing safety.
- Physical protection and emergency preparedness.
- Basic design principles.
- Assessment, review and reporting of safety.
- Operations of the facility.
- On-site management of nuclear materials and waste.
- Reporting to SSM of deficiencies, incidents and accidents.
- Documentation and archiving of safety documents.
- Final closure and decommissioning.

Since November 2012 the following earlier regulations have been incorporated into SSMFS 2008:1:

- Regulations on the Planning Before and During Decommissioning of Nuclear Facilities (SSMFS 2008:19). These regulations contain provisions concerning decommissioning planning and other administrative measures, e.g. documentation before and during decommissioning and reporting to the regulatory authority at different stages of a facility's life cycle.
- Regulations on the Handling of Radioactive Waste and Nuclear Waste at Nuclear Facilities (SSMFS 2008:22). These regulations contain provisions on predisposal management, e.g. on planning and quality assurance of radioactive waste management, on documentation and registration of radioactive wastes, also on reporting to SSM.

For most of the requirements, general advice on their interpretation has been issued.

Regulations concerning Safety in connection with the Disposal of Nuclear Material and Nuclear Waste (SSMFS 2008:21)

These regulations, in force since 2002, contain specific requirements on design, construction, safety analysis and safety reports for disposal facilities in view of the

period after closure of the facility. For the period before closure, the general safety regulations (SSMFS 2008:1) apply.

The regulations concerning long-term safety for the disposal of spent nuclear fuel and nuclear waste specifically cover:
- qualitative requirements on the barrier system,
- scenario definitions and classifications,
- time scales for the safety assessment (as long as barrier functions are needed to isolate and/or to retard dispersion of radionuclides, but for at least 10,000 years), and
- topics to be covered in the safety report.

Regulations on exemption from the requirement on approval of contractors (SSMFS 2008:7)
The general rule is that a licensee is not allowed to contract out an activity encompassed by the nuclear licence without a permit from the Government or SSM. For certain activities, the permit procedure may be replaced by notification made to the regulatory body. SSM is to specify the prerequisites for such exemptions.

The regulations list activities that are allowed to be contracted out without requiring a permit, e.g. building and construction work, decommissioning work, maintenance and inspection work, training, qualified expert tasks that cannot reasonably be performed using own staff, and archiving of safety documentation. It is pointed out that the exempted activities must only form parts of what is required under the licence, though not all, or major, parts. Furthermore, exempted activities are not allowed to include security measures and activities for storage and disposal of nuclear material or waste.

Regulations on Physical Protection of Nuclear Facilities (SSMFS 2008:12)
These regulations contain requirements on organisation of physical protection, clearance of staff, tasks for the security staff, central alarm station, perimeter protection, protection of buildings, protection of compartments vital for safety, access control for persons and vehicles, protection of control rooms, communication equipment, searching for illegal items, handling of information about the physical protection and IT security. Design details about the physical protection are to be reported in a classified attachment to the SAR of the facility.

Regulations on the Management of Contaminated Ash (SSMFS 2012:3)
These regulations apply to the production of energy by using forest biofuels in incineration facilities producing 30 tonnes or more of ash in yearly volume. The regulations contain precautionary provisions regarding the handling of ash for different options, such as returning the ash to the forests for nutrition, spreading the ash on agricultural and grazing land for nutrition and reusing the ash as roadfill or landfill, also governing the design of the waste disposal site if the ash is deposited.

Regulations on the Protection of Human Health and the Environment from Discharges of Radioactive Substances from certain Nuclear Facilities (SSMFS 2008:23)
These regulations contain provisions on releases of radioactive substances from nuclear facilities during normal operation based on optimisation of radiation pro-

tection. Compliance is to be achieved by using the best available technique (BAT). The optimisation of radiation protection shall include all facilities located within the same geographically delimited area. The effective dose to an individual in the critical group of one year of releases of radioactive substances to air and water from all facilities located in the same geographically delimited area shall not exceed 0.1 millisievert (mSv).

Regulations on Radiation Protection Managers at Nuclear Plants (SSMFS 2008:24)
According to these regulations, a licence holder is required to appoint a radiation protection manager at the facility in order to implement radiation protection conditions issued by the authorities and to supervise compliance with these conditions.

Regulations on Radiation Protection of Workers Exposed to Ionising Radiation at Nuclear Plants (SSMFS 2008:26)
These regulations contain provisions on limitation of exposures as far as reasonably achievable while having taken into account societal and economic factors. For this purpose, the licence holder must ensure that goals and needed actions for control are established and documented and that the needed resources are available.

Regulations and General Advice on the Protection of Human Health and the Environment in connection with the Final Management of Spent Nuclear Fuel and Nuclear Waste (SSMFS 2008:37)
These regulations apply to the disposal of spent nuclear fuel and nuclear waste. They are not applicable to landfills for low-level nuclear waste. The basic requirement is that human health and the environment shall be protected from detrimental effects of ionising radiation, during operation as well as after closure. Another important requirement is that impacts on human health and the environment outside Sweden's borders are not permitted to be more severe than those accepted in Sweden. The regulations contain provisions on areas such as BAT and optimisation, the risk criterion and most exposed group, time periods for the risk analysis and demonstration of compliance for different time periods.

Regulations on Filing at Nuclear Plants (SSMFS 2008:38)
These regulations apply to the filing of documentation that has been drawn up or received in connection with the operation of nuclear plants. Certain documentation must be filed. If the practice ceases, the archives are required to be transferred to the National Archives of Sweden.

Regulations and general advice concerning clearance of materials, rooms, buildings and land in practices involving ionising radiation (SSMFS 2011:2)
These regulations contain provisions on the clearance of materials, rooms, buildings and land from activities involving ionising radiation. These regulations replace the former regulations in effect governing the clearance of goods and oil from nuclear facilities (SSMFS 2008:39).

Regulations on Basic Provisions for the Protection of Workers and the Public in Connection with Work involving Ionising Radiation (SSMFS 2008:51)
These regulations are general and apply to the exposure of workers and the public

in both planned and emergency exposure situations. They are based on European provisions in the EU BSS.[7] They contain fundamental requirements imposed on the licensee/operator for justification of the activities, optimisation of the radiation protection and limitation of individual doses (dose limits). They address the categorisation of workers and workplaces, stipulate Swedish dose limits for workers (including apprentices) and the public, and address the information required to be provided to pregnant or breastfeeding women as well as their protection.

The regulations address dose limitation in connection with emergency exposure situations. They stipulate rules for measurements, registration of individual radiation doses and how these should be reported to the national dose register.

The regulations contain provisions on medical surveillance, classification and medical records of workers as well as on rules for the accreditation of laboratories for individual dose monitoring and performance requirements of individual dose meters. The regulations also refer to the European technical recommendations for monitoring individuals exposed to external radiation (EUR 14852 EN, 1994).

Regulations on Outside Workers in Work involving Ionising Radiation (SSMFS 2008:52)
These regulations apply to outside workers of category A working within controlled areas in Sweden and when Swedish workers of category A perform similar tasks in other countries. The regulations impose obligations on both the licensee (e.g. operator of a nuclear facility) and the outside worker's undertaking. The regulations contain provisions on procedures to be followed by SSM for issuing individual radiological monitoring documents to outside workers in accordance with the EU Directive (90/641/Euratom).

Regulations on Radioactive Waste Not Associated with Nuclear Energy (SSMFS 2010:2)
These regulations apply to the handling of solid and liquid wastes from medical care, laboratories and scientific applications.

E.2.2.4 The Environmental Code

The objective of the Swedish Environmental Code is to promote sustainable development and thereby ensure a healthy environment for current and future generations. The Code includes general provisions on environmental protection. The Code is applicable to nuclear activities and activities involving radiation and must be applied in parallel with the Act on Nuclear Activities and the Radiation Protection Act. The Code is supplemented by a number of ordinances. These are laid down by the Swedish Government.

Safety requirements, etc.
Definitions
In the Code, environmentally hazardous activities are defined as:
- the discharge of wastewater, solid matter or gas from land, buildings or structures onto land or into water areas or groundwater,

[7] *Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation [O. J. L-159 of 29.06.1996].*

- any use of land, buildings or structures that entails a risk detrimental to human health or the environment due to discharges or emissions other than those referred to above, or to pollution of land, air, water areas or groundwater, or
- any use of land, buildings or structures that may be detrimental to the surroundings due to noise, vibration, light, ionising or non-ionising radiation or similar impact.

General rules of consideration

The general rules of consideration define several important principles that must be complied with by the implementer, e.g:

- The knowledge principle means that the implementer must possess the knowledge that is necessary regarding the nature and scope of the activity to protect human health and the environment against damage or detriment.
- The precautionary and BAT principles mean that the implementer shall put into practice protective measures, comply with restrictions, and take any other precautions that are necessary in order to prevent, hinder or combat damage or detriment to human health or the environment as a result of the activity. For the same reason, the best available technology shall be used in connection with professional activities.
- The most suitable site principle means that as regards activities for which land or water areas are used, a suitable site shall be selected while taking into account the goals of the Environmental Code. Sites for activities must always be chosen in such a way as to make it possible to achieve their purpose with a minimum of damage or detriment to human health and the environment.
- The after-treatment liability principle means that everyone who has pursued an activity that causes damage or is detrimental to the environment shall be responsible for restoring it to the extent deemed reasonable. An individual who is liable for after-treatment shall carry out or pay for any after-treatment measures necessary. The general rules of consideration function as a preventive tool and follow the principle that the economic risks of environmental impact should be borne by the polluter and not by the environment.

Environmental Impact Assessment (EIA)

Swedish EIA legislation is in accordance with the Council Directive 85/337/EEC of 27 June 1985, amended by Council Directive 97/11/EC of 3 March 1997 and by Directive 2003/35/EC of 26 May 2003, on the assessment of the effects of certain public and private projects on the environment. An EIA is to be submitted together with an application for a permit for environmentally hazardous activities. An EIA must also be submitted at the prospect of the decommissioning of nuclear facilities.

The purpose of an EIA is to establish and describe the direct and indirect impacts of a planned activity or measure on people, animals, plants, land, water, the air, the climate, the landscape and the cultural environment, on the management of land, water and the physical environment in general, and on the management of materials, raw materials and energy. Another purpose is to enable an overall assessment to be made of this impact on human health and the environment.

An environmental impact statement must have the following content:

- a description of the activity or measure including details of its location, design and scope;

- a description of the measures being planned with a view to avoiding, mitigating or remedying adverse effects, for example, action to prevent the activity or measure leading to an infringement of an environmental quality standard;
- the information that is needed to establish and assess the main impact on human health, the environment and management of land, water and other resources that the activity or measure is likely to have;
- a description of possible alternative sites and alternative designs, together with a statement of the reasons why a specific alternative was chosen and a description of the consequences if the activity or measure is not implemented; and
- a non-technical summary of the information.

Local consultation

In the EIA process, the implementer must consult with the county administrative board at an early stage. They shall also consult private individuals who are likely to be affected by the planned activity, and must do so in good time and to an appropriate extent before submitting an application for a permit and preparing the environmental impact statement. Prior to consultation, the implementer must submit information to the county administrative board and to any private individuals affected about the location, extent and nature of the planned activity and its anticipated environmental impact.

If the county administrative board decides that the activity or measure is likely to have a significant environmental impact, an environmental impact assessment procedure shall be performed. In such a procedure, the person who intends to undertake the activity or measure must consult with the other government agencies, the municipalities, the citizens and the organisations that are likely to be affected. The consultation shall relate to the location, scope, design and environmental impact of the activity or measure and the content and structure of the environmental impact statement.

Consultation with other countries

If an activity is likely to have a significant environmental impact in another country, the responsible authority as designated by the Government shall inform the responsible authority in that country about the planned activity. This is to give the country concerned and the citizens who are affected the opportunity to take part in a consultation procedure concerning the application and the environmental impact assessment. Such information shall also be supplied when another country that is likely to be exposed to a significant environmental impact so requests.

Sanctions

The supervisory authority may issue any injunctions and prohibitions that are necessary in individual cases to ensure compliance with the provisions of the Environmental Code and rules, judgements and other decisions issued in pursuance thereof.

Licensing

According to the Environmental Code, a permit is required for environmentally hazardous activities. The Government has in the Ordinance on Environmentally Hazardous Activities and Health Protection (1998:899) stipulated that facilities for the treatment, storage or disposal of spent fuel, nuclear waste or radioactive

waste need a permit. A permit is also needed for the decommissioning of nuclear reactors.

The Land and Environmental Court is the first instance for the hearing of cases concerning such activities. In addition, the Government must consider the permissibility of nuclear activities, e.g. the disposal of spent fuel and radioactive waste.

The Court's judgement when granting a permit for an activity may include provisions concerning supervision, inspections and checks, the safety and technical design of the activity and conditions that are necessary to prevent or limit any harmful or other detrimental impact.

Prohibition and revocation
Under the Code, a supervisory authority may in individual cases impose the injunctions or prohibitions that are required on an operator for compliance with the obligations of the Code.

Institutional control, regulatory inspection and documentation and reporting
Institutional control
See section E.2.3.3.

Regulatory inspection
The purpose of supervision shall be to ensure compliance with the objectives of this Code and rules issued in pursuance thereof. For this purpose, the supervisory authority is to supervise compliance with the provisions of the Environmental Code and rules, judgements and other decisions issued in pursuance thereof and take any measures that are necessary to ensure that faults are corrected. SSM supervises radiation safety matters under the Code.

By an amendment made on May 8, 2013 to the Ordinance on environmental inspection and enforcement under the Environmental Code, SSM is to provide regulatory guidance regarding supervision of pollution damage and other environmental damage caused by radioactive substances. The Swedish Environmental Protection Agency manages a national programme on remediation of contaminated land from past practices. Potentially contaminated areas are identified, investigated and classified. No area has yet been identified for remediation in respect of radioactive substances. However, the identification of potentially contaminated areas is an ongoing process. The amendment of the Ordinance should ensure that radiological impacts are given higher priority in the process of identifying contaminated sites for remediation.

Documentation and reporting
See section E.2.3.3.

Enforcement of regulations and terms of licences
See section E.2.3.4.

Clear allocation of responsibilities
See section E.2.3.5.

E.2.2.5 The Act on Financial Measures for the Management of Residual Products from Nuclear Activities

The purpose of the Act on Financial Measures for the Management of Residual Products from Nuclear Activities (2006:647; the 'Financing Act') is to ensure the financing of the general obligations imposed by the Act on Nuclear Activities.

The obligations to ensure funding apply to all licensees of a nuclear facility. The primary purpose of the Swedish financing system is to secure the financing of the licensees' costs for handling and disposing of residual products, decommissioning and dismantling of nuclear facilities and carrying out needed research and development activities, but also minimising the State's risk of being forced to bear the costs considered to be a licensee liability.

Definitions

'Residual product' is defined as:

- nuclear materials that will not be used again,
- nuclear waste which is not operational waste.

'Nuclear waste fee' is defined as the fee for:

- the licensees' costs for safe handling and disposal of residual products,
- the licensees' costs for safe decommissioning and dismantling of nuclear facilities,
- the licensees' costs for research and development needed for these activities,
- the State's costs for research and development needed to review these measures,
- the State's costs for administration of funded means and review of measures taken according to the Financing Act,
- the State's costs for supervision of safe decommissioning and dismantling of nuclear facilities,
- the State's costs for review of issues relating to disposal, and surveillance and control of a disposal facility,
- the licensees', State's and municipalities' costs for providing information to the public on management and disposal of spent nuclear fuel and nuclear waste, and
- the costs for providing financial support to non-profit organisations for efforts in connection with the siting of facilities for management and disposal of spent nuclear fuel.

Obligation to pay the nuclear waste fee and provide guarantees

The licensee of a nuclear facility that generates or has generated residual products must pay a nuclear waste fee. This fee is to cover the licensee's share of the total costs.

The licensee of a nuclear power reactor must pay a nuclear waste fee. As far as concerns other licensees, there is a possibility to allow an exemption to an obligation to pay a nuclear waste fee if the licensee provides a guarantee to cover the costs of its handling and disposal of residual products.

In addition to the obligation to pay a nuclear waste fee, the licensees must also provide guarantees. The purpose of the guarantees is to ensure adequate reserves for future financing if funded means should be proven to be inadequate.

The obligation to pay the nuclear waste fee and provide guarantees will end when the licensee has performed its obligations under the Act on Nuclear Activities or has been granted an exemption from them.

Administration of funds
The fees are collected in a nuclear waste fund. The Nuclear Waste Fund is an independent government authority that controls and administers this fund.

The financial risk of the State
As mentioned previously, the State has the ultimate responsibility for long-term and safe management of spent fuel and radioactive waste. This responsibility also includes a financial obligation.

Usage of funds and guarantees
The accumulated funds shall be used solely to reimburse for the costs which the nuclear waste fee is intended to cover. If the Nuclear Waste Fund is proven inadequate, the guarantees shall be used to cover the costs.

If fund assets remain for a fee-liable licensee after all costs relating to that specific licensee have been paid, the excess of funds shall be repaid to the licensee or the payer.

Inspection
A licensee is obligated to submit cost estimates and other information which might be required to fulfil the purpose of the Financing Act.

Sanctions
A licensee that intentionally or through grave negligence disregards its obligations by submitting incorrect information will be ordered to pay a fine, unless the action is punishable under the Penal Code.

E.2.2.6 The Ordinance on Financial Measures for the Management of Residual Products from Nuclear Activities (2008:715)

Cost estimates
The legislation requires the licensees to every three years submit estimates of all future costs for management and disposal of spent nuclear fuel and nuclear waste, and decommissioning. The licensee of a nuclear power reactor shall base its cost estimates on 40 years of operation with a minimum remaining period of operation of 6 years. The licensee of a nuclear facility other than a nuclear power reactor shall base its cost estimates on the expected remaining period of operation.

The cost estimates are submitted to SSM for review. SSM shall for each of the reactor licensees prepare a proposal for the nuclear waste fee that the reactor licensee is to pay over the following three calendar years.

SSM shall prepare the proposal:
- based on the cost estimates,
- taking into account the total added cost[8], and
- so that all expected costs, after having taken into account previous payments, are expected to be covered by the fees that the reactor licensee will pay over the remaining operating period of the reactor.

[8] *The added costs are those of the state, municipalities and non-profit organisations.*

If there are special reasons, SSM may order a licence holder to submit a cost estimate earlier than within three years or to submit an additional cost estimate. If a supplementary cost estimate has been submitted or if there are special reasons for doing so, SSM may propose nuclear waste fees for a period of less than three years. For licensees of a nuclear facility other than a reactor, SSM may decide on nuclear waste fees for a period of less than three years.

Guarantees
In addition to paying a fee on nuclear energy generation to the Nuclear Waste Fund, the nuclear power reactor licensees must provide two types of guarantees. One guarantee is to cover the discrepancy between funded means and estimated costs. The other type of guarantee is to cover unforeseen events and be available until all reactors have been decommissioned and all nuclear waste has been disposed of in a disposal facility. This guarantee will be utilised if expenses for future costs are higher than expected, if these expenses must be met earlier than expected, or if the actual amount in the fund is lower than estimated.

The licensees of nuclear facilities other than nuclear power reactors also must provide a guarantee to cover the discrepancy between accumulated funds and estimated costs.

Management of assets
The assets in the Nuclear Waste Fund shall be managed to ensure a good return and satisfactory liquidity. The Nuclear Waste Fund's assets shall be deposited in an interest-bearing account at the National Debt Office, in treasury bills issued by the state or in covered bonds. The return on the fund's assets shall be added to the capital.

Disbursements to licensees
The licensees are entitled to disbursements on a continuous basis for expenses which they have already incurred for measures to achieve the decommissioning, handling and disposal of spent nuclear fuel and nuclear waste, including the research needed for these activities. The remainder of the funds is accumulated for future needs. The financial resources should only be used for the purpose for which they have been established and managed.

Disbursement to municipalities
Municipalities where there are site investigations of the disposal facility for spent nuclear fuel, or where a facility for such a disposal facility is planned or being built, are entitled to compensation from the Nuclear Waste Fund for their information to the public. Disbursements may be determined to no more than 10 million SEK (about 1.1 million euro) per municipality and twelve-month period. Currently the municipalities of Östhammar and Oskarshamn are receiving disbursements from the Nuclear Waste Fund.

Disbursement to non-profit organisations
According to Government bill 2003/04:116, the issue of disposal of spent fuel and radioactive waste is one of the most complex issues in our time, where science and technology meet social science and humanistic issues. The bill concludes that the complexity of the issue requires comprehensive evaluation as a basis for future

decisions involving all stakeholders in society. Therefore, in 2004 the Parliament approved new regulations in the Financing Act, which made it possible for non-profit organisations to apply for financing.

To be eligible for financing, the non-profit organisations must have at least 1,000 members, a democratically elected board and a charter of the association decided by the associations' assembly. Support may be provided with a total amount of 5 million SEK (about 0.55 million euro) per calendar year and with a maximum of SEK 2.5 million per organisation and calendar year.

The non-profit organisations are eligible to financial support from the Nuclear Waste Fund until 12 months after the Environmental Impact Assessment has been announced by the Land and Environmental Court.

Supervision of the overall system

SSM reviews the cost estimates according to the Financing Act and then suggests the level of the nuclear waste fees and guarantees to the Government. The Government sets the fees and guarantees for the licensees of nuclear power reactors. The Swedish Radiation Safety Authority sets fees and guarantees for the licensees of nuclear facilities other than nuclear power reactors.

The Swedish Nuclear Waste Fund (formerly known as the Board of the Swedish Nuclear Waste Fund) administrates and manages the collected fees.

The Swedish National Debt Office administrates and manages the guarantees. SSM decides on the disbursement of funds to the nuclear licensees, the municipalities and the non-profit organisations. Furthermore, SSM has the responsibility to check that the nuclear utilities have made their payments to the Fund and also to audit the disbursements.

E.2.2.7 The Act on Financing of Certain Radioactive Waste, etc. (1988:1597)

Since 1989, a special fee has been levied on nuclear power utilities under the Act on Financing of Certain Radioactive Waste, etc. (1988:1597), the so-called 'Studsvik Act'. This fee is intended to cover expenses for the management of nuclear waste from older experimental facilities.

The Government decided earlier that the Studsvik Act would cease to be in effect by the beginning of 2012. In 2009 the Government commissioned SSM to investigate future costs, uncertainties and responsibilities, and to evaluate in depth the problems and financial risks that might arise if the Act were to expire in 2012. If SSM found it appropriate, the mission also included proposing constitutional amendments.

SSM submitted its report to Government in March 2010. The SSM assessment resulted in the conclusion that the combined impacts of the uncertainties identified are expected to lead to a future need for funds that is greater than indicated in the current cost estimates. Furthermore, if the contributions to the fund according to the Studsvik Act were to cease, the economic risk of the state would increase. The assessment of SSM is that the Studsvik Act should remain in force until further notice.

In June 2011 the Parliament approved a Government Bill (2010/2011:126) containing a proposal to extend the obligation to pay fees under the Studsvik Act until the end of 2017. The reformed legislation entered into force on 1 January 2012.

Obligation to pay a fee under the Studsvik Act
A fee shall be paid to the State as a contribution towards costs of the following measures:

- decontamination and decommissioning of the research reactors R2 and R2-0 in Studsvik and associated buildings,
- decontamination and decommissioning of the district heating nuclear power reactor in Ågesta,
- decontamination and decommissioning of the central active laboratory (ACL & ACF), hot cell laboratory (RCL), van der Graaf laboratory, incinerator facility (RA), treatment facility for intermediate level waste (RM), storage facility (FA), storage facility for intermediate level waste (rock cavity; AM), dry storage facility for solid intermediate waste (AT), facility for liquid waste treatment (TS), waste storage facility (AU), waste storage facility (UF), waste storage facility (AS 1-4), waste storage facility (UA) and evaporation facility (ID),
- management and disposal of nuclear and other radioactive waste generated by 30 June 1991 as a result of nuclear activities or stored at the nuclear facilities referred to above,
- management and disposal of nuclear fuel from research reactor R1 in Stockholm and the district heating nuclear power reactor in Ågesta, and the fuel elements from the research reactor R2 in Studsvik that were adjacent to the reactor on 30 June 1991,
- restoration of the plant in Ranstad as a result of nuclear activities conducted in the past, and
- radiation protection measures which by law are necessary as a result of the activities referred to above.

Licensees operating nuclear reactors are liable to pay a fee according to the Studsvik Act. The fee is 0.003 SEK per kWh of electricity generated by nuclear power. The fees are collected in a fund, the Studsvik Fund. The Nuclear Waste Fund administers the Studsvik Fund and the fund is managed together with the funds accumulated according to the Financing Act.

Cost estimates
An entity licensed for the activities governed by the Act on Nuclear Activities, or having been granted consent by SSM or another entity, is required to submit an estimate of its costs.

The estimated costs shall include both an estimate of the costs of all the measures that can be considered to be necessary, and a breakdown of the costs of the action to be taken within the next three years. The cost estimate shall be updated and submitted to SSM annually.

Disbursements
Fees paid under this Act may only be used to reimburse costs incurred for the activities listed. The remainder of the funds is accumulated for future needs. The Swedish Radiation Safety Authority decides on the disbursement of funds.

If there is any excess of funds as the last activity is completed, the surplus Studsvik fees in the Fund go to the state.

Inspections and Sanctions
The licensee of a nuclear power reactor and the licensee obligated to estimate costs must at the request of SSM provide the information and the documents necessary for SSM's activities under this Act.

A licensee that intentionally or negligently provides incorrect information or otherwise acts contrary to its obligations will be ordered to pay a fine unless the offence is punishable under the Penal Code.

E.2.2.8 Non-nuclear activities

According to the Radiation Protection Act, any party that has produced radioactive waste is required to ensure the safe management and disposal of the waste, including securing financial resources. This applies to all non-nuclear activities where radioactive materials are used: medicine, industry, agriculture, research and education.

E.2.2.9 Other Relevant Acts

The Act on the Control of Dual-use Items and Technical assistance (2000:1064)
The export of nuclear material and equipment is governed by the Act on the Control of Export of Dual-use Products and Technical Assistance, as well as by Council Regulation (EC) No 428/2009 of 5 May 2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items, see also information under Article 27, section I.1.1.

The Civil Protection Act
The Civil Protection Act (2003:778) contains provisions on how community rescue services shall be organised and operated. According to the Act, the county administrative board is responsible for rescue operations in cases where the public needs protection from a radioactive release from a nuclear installation or in cases where such release seems imminent. The Act also stipulates that a rescue commander with a specified competence and having extensive authority is to be engaged for all rescue operations. In addition, the Act requires the owner of hazardous installations to take the measures necessary to minimise any harm to the public or environment if an accident were to occur in the installation.

The Civil Protection Ordinance (2003:779) contains general provisions concerning emergency planning. The county administrative board is obliged to draw up a radiological emergency response plan. The Swedish Civil Contingencies Agency (MSB) is responsible at national level for co-ordination and supervision of the preparedness for rescue services response to a radioactive release. The Swedish Radiation Safety Authority decides on necessary measures for nuclear installations.

The Occupational Safety and Health Act
The Occupational Safety and Health Act (1977:1160) contains requirements on the work environment and provisions on protection from accidents caused by technical equipment, dangerous materials or other work conditions. The Act also contains detailed rules concerning responsibility and authority with respect to occupational safety issues.

The Act on Transportation of Hazardous Goods
The Act on the Transportation of Hazardous Goods (2006:263) and the Ordinance (2006:311) on the Transportation of Hazardous Goods contain provisions in order to prevent, hinder and limit damage caused by transport of dangerous goods.

E 2.3 National Safety Requirements and Regulations

Essential Swedish legislation containing requirements for safety and radiation protection as specified therein has been presented above.

This section describes the legislative and regulatory system that has been established in Sweden comprising a system for licensing, the possibility to revoke licences and prohibit activities, institutional control, regulatory inspection, documentation and reporting, enforcement of regulations, licence terms and clear allocation of responsibilities of the bodies involved.

E.2.3.1 Licensing

The following text describes the licensing system for the treatment and disposal of spent fuel, radioactive waste, very low level radioactive waste and non-nuclear radioactive waste. In this context the system of release is also mentioned.
Figure E2 shows a general schematic illustration of the licensing procedure for nuclear facilities.

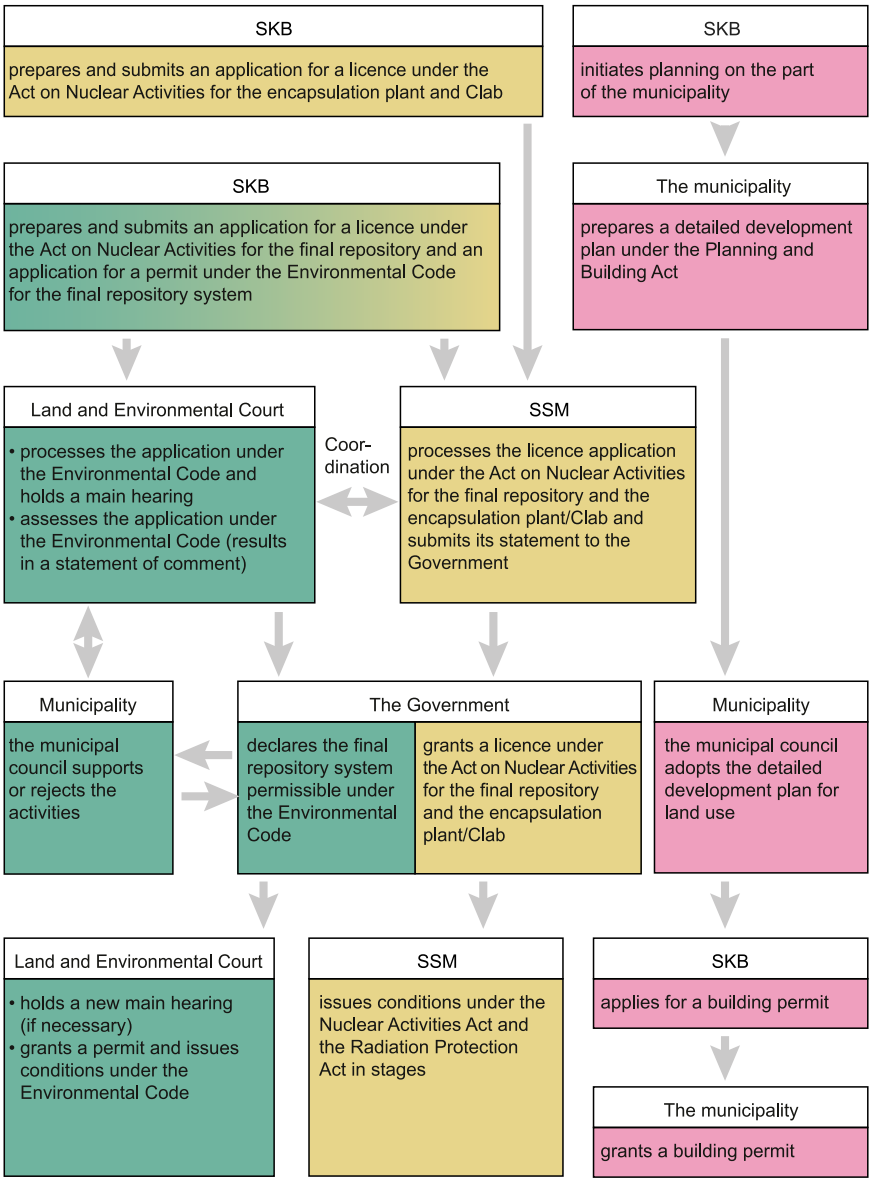

Figure E2: Licensing procedure for nuclear facilities, exemplified using SKB's application for an encapsulation plant and a final repository for spent nuclear fuel.

Facilities for the management and disposal of spent fuel and radioactive waste

General

Licensing is governed by several acts having different purposes and involves a number of authorities. A general permissibility consideration has to be made as to whether or not to grant a permit for an activity. Furthermore, an activity must be approved in accordance with aspects of radiation safety and to ensure the protection of human health and the environment. Lastly, licensing conditions are issued under the various acts by the authorities responsible.

During the licensing process, an important instrument is the Environmental Impact Assessment (EIA). Early consultation with the private individuals likely to be affected, as well as with the government agencies, municipalities and organisations concerned, is emphasised in Swedish EIA legislation. The consultations must relate to the location, scope, design and environmental impact of the activity and to the content and structure of the Environmental Impact Statement (EIS). If an activity or measure is likely to have a significant environmental impact in another country, the responsible authority designated by the Government must inform the responsible authority in that country about the planned activity or measure and give the country concerned and the citizens affected the opportunity to take part in a consultation procedure concerning the application and the environmental impact assessment.

Permissibility

According to the Environmental Code, the Government is to consider the permissibility of certain activities such as interim storage or the disposal of spent fuel or radioactive waste. An environmental impact statement must be submitted for the permissibility assessment. The Land and Environmental Court reviews an application on permissibility, which is thereafter forwarded to the Government for final consideration.

According to the Environmental Code, the Government may decide on the permissibility only if the municipal council concerned agrees that the activities may be located in the municipality (municipal veto). However, without prejudice to the municipal approval, the Government may permit an activity that involves interim storage or disposal of spent fuel or waste if the activity is of utmost importance with regard to national interests. This shall nevertheless not apply in cases where another site is considered to be more appropriate for the activity, or if an appropriate site has been designated for the activity in another municipality that is likely to approve the activity.

Licensing approval

If the Government grants permissibility according to the Environmental Code, licensing approval needs to be issued for the nuclear activity according to the Act on Nuclear Activities and for the environmentally hazardous activity according to the Environmental Code. The Government (or the authority appointed by the Government) grants a licence in accordance with the Act on Nuclear Activities. The application is reviewed by the regulatory authority assigned by the Government and forwarded thereafter for a Government decision. A licence under the Radiation Protection Act is not required for activities covered by the Act on Nuclear Activities. Following a Government permissibility decision, the Land and Environmental Court grants a licence and issues conditions on environmentally hazardous activities under the Environmental Code.

It may be noted that the preparation and review of an application, as well as issuing a licence and conditions, take place in open court hearings at the Land and Environmental Court. At that hearing, all interested parties may attend and comment, also the relevant authorities. The applicant must verbally describe all relevant aspects of its case. Questions can be submitted during the proceedings.

SSM may issue conditions under the Act on Nuclear Activities and the Radiation Protection Act in a step-wise authorization process following a Government licensing decision.

Shallow land burials

General

Shallow land burial is used in Sweden for very low-level radioactive waste from nuclear activities. The highest accepted level that can be licensed by SSM is limited by the ordinance to 10 TBq, of which a maximum of 10 GBq may consist of alpha-active substances. For repositories with higher activity content, the licences are granted by the Government. The licensing procedures according to the Environmental Code for this kind of disposal facility also differ from the licensing of other repositories for nuclear waste as there is no need for a Government permissibility consideration before the Land and Environmental Court can issue a licence.

Similar to other repositories for nuclear waste, two applications are to be filed: one according to the Act on Nuclear Activities and one according to the Environmental Code. The applications will be filed to both SSM and the Land and Environmental Court. An important instrument during the licensing process is the Environmental Impact Assessment (EIA), which is required as a part of both licence applications. The applicant should involve the private individuals, government agencies, municipalities and organisations concerned in a consultation procedure. The consultations must relate to the scope, design and environmental impact, and to the content and structure of the environmental impact statement (EIS).

Licensing approval

In the Act on Nuclear Activities, shallow land burial for very low-level radioactive waste is defined as a nuclear activity and consequently must be licensed under this Act. The regulatory authority assigned by the Government grants licences for shallow land burials according to the Act on Nuclear Activities. Furthermore, shallow land burial is defined as an environmentally hazardous activity and must be approved under the Environmental Code by the Land and Environmental Court.

Licensing conditions

Licensing conditions can be issued under the Act on Nuclear Activities, the Radiation Protection Act and the Environmental Code. This means that the Swedish Radiation Safety Authority and the Land and Environmental Court can issue the conditions necessary from specific aspects concerning nuclear safety, radiation protection and environmental protection, respectively. Conditions may be issued in connection with licensing or during the period of validity of the licences. As of 2011, SSM is the supervisory authority of radiation safety conditions issued according to the Environmental Code. The county administrative board previously supervised all parts of the licence and licence conditions according to the Environmental Code.

Radioactive waste from medical use, research and industry

Handling and disposal of radioactive waste from medical use, research and industry require a licence under the Radiation Protection Act and Environmental Code.

Clearance

Clearance of nuclear materials or nuclear waste must be in accordance with the Act on Nuclear Activities as well as with the Radiation Protection Act, and approved by the regulatory authority. Material may be cleared for unrestricted use, or for disposal as conventional non-radioactive waste. A licence according to the

Environmental Code, as is applicable to non-radioactive waste, may be needed if material that has been "cleared" is to be disposed of as non-radioactive waste, see also sections A.6.2.2 and F.6.1.

E.2.3.2 Prohibition

It is prohibited to carry out nuclear activities or activities involving radiation without a permit. Any person who deliberately, or through negligence, operates an activity without the necessary permits shall be fined or sentenced to not more than two years' imprisonment. The same penalty (for unauthorised environmental activity) applies under the Environmental Code.

E.2.3.3 Institutional control, regulatory inspection and documentation and reporting

Institutional control

According to regulations on radiation protection[9], the licence holder must conduct environmental monitoring. All discharges from facilities for storage or disposal of radioactive waste must be monitored by a nuclide specific measuring programme. The dose to any individual in the critical group is not allowed to exceed 0.1 mSv/y. The regulations are applicable to facilities in operation, but will be amended in due time to cover the period following closure of a disposal facility for spent nuclear fuel and radioactive waste.

SSM has also issued conditions regarding institutional control of existing shallow land disposal facilities. The regulations stipulate that institutional control shall continue until the radioactivity no longer is a "significant" hazard to public health and the environment. The municipalities' detailed development plans are also of importance by providing conditions concerning the use of the land. All nuclear facilities, including shallow land disposal facilities, are within areas where detailed development plans have been established.

Inspections

In accordance with legal authorisation and the mandate defined by the Government[10], the Authority conducts regular inspections and assessments of Swedish nuclear facilities to ascertain compliance with regulations and licence conditions.

Supervision of compliance with the Act on Nuclear Activities and the Radiation Protection Act, as well as conditions or regulations imposed under the Acts, is performed by SSM. SSM also fulfils supervision of the compliance with the Environmental Code and conditions or regulations imposed by the Code for questions concerning radiation safety. As far as concerns other environmental aspects covered by the Code, the county administrative board performs supervision.

The implementer must on request submit to the Authority the information and documentation required for its supervision. The Authority is also to be given access to the installation or site where the activities are conducted for investigations and sampling to the extent required for supervision, see also sections E.2.2.1 and E.2.2.2.

[9] *Regulations on the Protection of Human Health and the Environment from Discharges of Radioactive Substances from certain Nuclear Facilities (SSMFS 2008:23).*

[10] *Ordinance on Financial Measures for the Management of Residual Products from Nuclear Activities (2008:715).*

More about SSM's supervisory practices in detail

SSM has continued to develop its supervisory methods, which are also documented as part of SSM's overall management system. Inspection policies and routines established in 2009 have been updated, and new routines, including harmonization between procedures in different supervisory areas, have been issued. The following list exemplifies (i.e. is incomplete) relevant documents from SSM's management system:

1.	Supervisory policy	2013-06-27
2.	Rules of access to facilities under the Authority's supervision	2009-05-19
3.	Intensified supervision	2013-01-08
4.	Compliance inspections	2013-06-27
5.	Surveillance inspections	2013-06-27
6.	Reviews	2013-06-27
7.	Rapid investigations	2013-06-27
8.	Processing notifications from nuclear facilities	2011-01-24
9.	Integrated safety assessments	2012-05-01
10.	Compliance assessments and sanctions in supervision	2013-02-27
11.	Investigations in supervision	2012-09-04

SSM's supervisory practices for nuclear installations

In total, 17 areas are defined for which the corresponding requirements are found in regulations, licensing conditions and to some extent in regulatory decisions. The ambition is to successively cover these areas in a basic inspection programme and to document the inspection findings.

Moreover, the same 17 areas are applied in the annual assessments of the licensees (SSM's integrated safety assessments, see below) as well as in the periodic 10-year safety reviews. In this way, SSM is able to systematically supervise the safety situation and monitor developments. When new assessments are begun, previously performed and documented assessments of the areas can be consulted and any emerging picture consolidated. The idea is to apply the regulatory information and knowledge in a more efficient way. In order to further guide inspection and safety assessment work, each of the 17 areas also have a sub-structure.

The areas applied are:

1. Design and construction of facilities, including modifications.
2. Organisation, management and control of the nuclear activity.
3. Competence and staffing of the nuclear activity.
4. Operations, including handling of deficiencies in barriers and the defence-in-depth.
5. Core and fuel issues and criticality issues.
6. Emergency preparedness.
7. Maintenance, including materials and control issues with special consideration of degradation due to ageing.
8. Primary and independent safety review, including the quality of notifications to SSM.
9. Investigation of events, experience feedback and external reporting.
10. Physical protection.
11. Safety analyses and safety analysis report.

12. Safety programme.
13. Archiving and handling of plant documentation.
14. Management of nuclear material and radioactive waste.
15. Nuclear non-proliferation, export control and transport safety.
16. On-site radiation protection.
17. Radiation protection of the general public and environment.

As a result of assessments within these areas, safety conclusions can be drawn in terms of the integrity of the physical barriers and the functioning of the five levels of the defence-in-depth.

In the regulations SSMFS 2008:1, the areas 1-15 are found in the general advice section (Chapter 4, section 4) on periodic reviews of nuclear safety. The licensees are encouraged to analyse and report on their activities according to these areas. The added areas 16 and 17 cover issues regulated by the Radiation Protection Act.

SSM evaluates how regulatory time "on site" is used and how to optimise the time allocated to compliance inspections and surveillance inspections as described below in order to be able to assess actual work practices at the plants, though without taking over inspection issues already under third party control.

Documentation and reporting

In SSM's Regulatory Code, SSMFS, a requirement is imposed on extensive reporting from licence holders. In this context, the following reports can be mentioned:

Annual integrated report to SSM of activities at the facility with experience gained and conclusions reached with regard to safety.

- Annual report to SSM on the management of nuclear waste:
  1. the quantities of nuclear waste occurring on the site or that have in any other way been transferred to this site,
  2. nuclear waste that has been transferred to disposal or which has been transported from the facility for processing or storage at another facility, or which has been subjected to clearance,
  3. nuclear waste at the site at year-end, indicating the nuclide and the places where nuclear waste is stored, and
  4. operating experience from waste management, and monitoring of waste management plans.

- Annual information to SSM from all licensees of high activity sources (HASS) about the following:
  1. when a new source has been acquired,
  2. if the conditions specified in a record sheet have changed,
  3. when the holder has transferred the source to a new holder or to a recognised installation, supplemented with information about the recipient of the source, and
  4. when the practice has ceased and no sources are held.

- A deficiency in any of the repository's barrier functions that is detected during the construction or operational surveillance of the repository, and that can lead

to deterioration in safety after closure in addition to what is anticipated in the safety analysis report, must be reported to SSM without unnecessary delay. The same applies if such a deficiency is suspected to occur or if it is suspected that such a deficiency may possibly occur in the future.

- The licence holders shall, on the part of nuclear power reactors:
  1. annually report to SSM on the measures that have been taken or are planned to be taken in order to limit the discharge of radioactive substances with a view to reaching the goal values. If the reference values are exceeded, the measures planned with a view to reaching the reference values shall be reported;
  2. semi-annually report to SSM on the discharge of radioactive substances into air and water, shown as discharge of activity, and doses to individuals in a reference group; and
  3. semi-annually report to SSM on the results of environment checks.

- At least once every ten years, licensees are required to perform a periodic safety review (PSR), i.e. an integrated analysis and assessment of the safety of a facility. The periodic safety reviews are submitted to the regulatory authority, which conducts a comprehensive review and assessment of the submitted review and its references. This is documented in the form of a review report. In the case of nuclear power reactors, the report is submitted to the Government.

Reporting requirements also apply to SSM according to the appropriation directions, Government decisions and acts and ordinances. In this context, the following reports may be mentioned:

- Annual Activity Report and Financial Statement, with a summary of results, effects and costs of the regulatory activities, in accordance with general regulations issued by the Government and the Swedish National Audit Office for such annual reports issued by all government authorities. In its annual report, SSM gives an overview of the Authority's supervisory activities and the status of radiation safety in society.
- Every three years, the regulatory authority is required to submit to the Government a review report on the Nuclear Industry Research, Development and Demonstration Programme on Disposal of Spent Fuel and Nuclear Waste and the Dismantling and Decommissioning of Nuclear Installations (the SKB RD&D programme). In addition to the findings, conclusions and recommendations as to the purposefulness and quality of the programme, the review report also proposes conditions for the future conduct of the SKB RD&D programme that the Government may wish to prescribe in accordance with the Act on Nuclear Activities.
- Every three years, the regulatory authority appointed by the Government is required to submit a proposal for the nuclear waste fees to be paid by the licensees of nuclear power reactors to cover the costs for the disposal of spent fuel and nuclear waste and the dismantling and decommissioning of nuclear installations. The regulatory authority also includes a review report on the cost estimates provided by the licensees.
- The regulatory authority assigned by the Government shall on an annual basis report to the Government on the licences granted concerning export, import

or the transit of nuclear waste and the construction, possession or operation of shallow land burial sites.
- The regulatory authority also issues reports to a number of organisations, such as UNSCEAR, OECD, the IAEA, etc. on a regular basis, in compliance with international conventions. Most of this reporting is within the area of environmental radiation protection, but some parts also consider occupational radiation protection.

In addition to the above-mentioned reports, the regulatory authority also issues periodic reports in order to inform the public of major activities.

The regulatory authority also issues reports in which R&D results and important regulatory assessments are published. All reports published by the regulatory authority are open to the media and the public.

E.2.3.4 Enforcement of regulations and terms of licences

The authorities have extensive legal, regulatory and enforcement powers. As described in section E.2.3.2 concerning prohibition, a licence may be revoked for activities that do not fulfil the obligations set out in the legislation. If there is an ongoing licensed activity that does not comply with regulations or terms of the licence, the supervisory authorities may issue any injunctions and prohibitions required in the specific case to ensure compliance. Injunctions or prohibitions under the Acts may carry contingent fines.

If a person fails to carry out a measure incumbent upon him or her under the Acts or Ordinances, or regulations or conditions issued pursuant to the Acts, or under the supervisory authority's injunction, the authority may arrange for the measure to be taken at his or her expense.

E.2.3.5 Clear allocation of responsibilities of the bodies involved

The Swedish legal framework allocates a clear division of responsibilities between the bodies involved. As already mentioned, the producer of spent fuel and radioactive waste has the responsibility of safely handling and disposing of the waste produced. All the necessary measures and precautions should be taken by the waste producer. The authorities independently supervise, regulate and review existing or planned activities involving spent fuel and radioactive waste.

The ultimate responsibility for ensuring the safety of spent fuel and radioactive waste rests with the State. According to a Government statement, the ultimate responsibility of the State "is a matter of course" and does not need to be implemented in the legislation.

E.2.4 Conclusion

Sweden complies with the obligations of Article 19.

E.3 Article 20: 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 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.
2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate steps to ensure the effective independence of the regulatory functions from other functions where organisations are involved in both spent fuel or radioactive waste management and in their regulation.

E.3.1 Regulatory bodies and their mandates

E.3.1.1 General information

The legal basis for regulatory activities in Sweden is the Swedish constitution. By law, Parliament may hand over regulatory mandates to the Government or to the authority designated by the Government.

Through annual government appropriation directions and specific governmental decisions, including specific licensing decisions, the Government can also give specific assignments to a regulatory body.

The Swedish Radiation Safety Authority (SSM) is a central administrative authority under the auspices of the Ministry of the Environment. SSM is the regulatory body in Sweden authorised to supervise spent fuel management and radioactive waste management according to the Act on Nuclear Activities and the Radiation Protection Act. According to the Swedish constitution, the administrative authorities are quite independent within the legislation and statutes given by the Government. An individual minister cannot interfere in a specific case handled by an administrative authority.

Swedish Government ministries are small units when comparing with ministries in most other countries. Their main responsibilities are:

1. preparing the Government's bills to Parliament on budget appropriations and acts;
2. issuing acts, regulations and general rules for the administrative authorities;
3. international relations;
4. appointment of higher officials in the administration; and
5. certain appeals from individuals that are addressed to the Government.

The Cabinet of ministers is collectively responsible for all Government decisions. Although a large number of routine matters are in practice decided upon by individual ministers, and only formally confirmed by the Government, the principle of collective responsibility is reflected in all forms of governmental work.

The Director General of the Swedish Radiation Safety Authority is appointed by the Government, normally for a period of six years. As all other Swedish

authorities, SSM issues an annual report and financial statement, submitted to the Government, which summarize major results, effects, revenues and costs. The Government carries out follow-up work and evaluates the Authority's operations based on this report.

The level of requirements imposed on SSM and other Swedish authorities for openness and provision of information services to the public, politicians and media is very high. Swedish official documents are public unless a decision has been made to classify them according to the Public Access to Information and Secrecy Act (2009:400). The reasons for secrecy might be due to the interests of national security, international relations, commercial relations, or of individuals' right to privacy. No one needs to justify a request to view a public document or to reveal their identity in order to gain access to a particular document.

E.3.1.2 The Swedish Radiation Safety Authority (SSM)

SSM is the national regulatory body with responsibility in the area of nuclear safety, radiation protection and nuclear non-proliferation.

The Swedish Radiation Safety Authority (SSM) was founded on July 1, 2008 by means of a merger between the former authorities, the Nuclear Power Inspectorate and the Radiation Protection Authority. The main justification for the merger was to strengthen the supervision of both nuclear and non-nuclear activities relating to nuclear safety and radiation protection. Now that six years have passed, it can be observed that the consolidation has led to a more cohesive and effective regulatory authority. When established, SSM reissued the former authorities' regulations in the form of its own regulatory code, the SSMFS series. Figure E3 illustrates SSM's present organisation.

SSM's missions and tasks are defined in the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452) and in the annual appropriation directions. The Ordinance states that SSM is the administrative authority for protection of people and the environment against harmful effects of ionising and non-ionising radiation, for issues of nuclear safety including physical protection in nuclear technology activities as well as in other activities involving radiation, and for issues regarding non-proliferation.

SSM shall work actively and preventively to promote high levels of nuclear safety and radiation protection in society, and through its activities, act to:

1. prevent radiological accidents and ensure safe operations and safe waste management at nuclear facilities;
2. minimise risks and optimise the effects of radiation in medical applications;
3. minimise radiation risks in the use of products and services, or which arise as a by-product in the use of products and services;
4. minimise the risks of exposure to naturally occurring radiation; and
5. contribute to an enhanced level of nuclear safety and radiation protection internationally.

SSM shall ensure that regulations and work routines are cost effective and straightforward for citizens and enterprises to apply and/or understand.

SSM shall deal with financial issues connected with the management of radioactive wastes from nuclear activities. The Authority informs the Nuclear Waste Fund about the size of payments and disbursements from the fund, planned or forecast, by each reactor operator or other relevant licensee, and about SSM's

own activities regarding financing issues, so that the Nuclear Waste Fund can fulfil its tasks.[11] SSM is in charge of the Swedish metrology institute for ionising radiation. SSM operates a national dose register and, as appropriate, issues national individual dose passports.

SSM also has a mandate to:

- carry out Swedish obligations according to conventions, EU-ordinances/ directives and other binding agreements (e.g. contact point, report drafting and to be the national competent authority);
- supervise that nuclear material and equipment are used as declared and in compliance with international commitments;
- carry out international cooperation work with national and multinational organisations;
- monitor and contribute to the progress of international standards and recommendations;
- coordinate the activities needed to prevent, identify and detect nuclear or radiological events, also to organise and lead the national organisation for expert advice to authorities involved in or leading rescue operations;
- contribute to national competence development within the Authority's field of activities;
- provide data for radiation protection assessments and maintain the competence to predict and manage evolving issues; and
- ensure public insight into all of the Authority's activities.

SSM publishes reports to inform interested parties and stakeholders. The SSM website is used to provide information on current events and official decisions. R&D reports and central regulatory assessments are published as part of the SSM report series.

All reports issued by SSM are publicly available (unless classified for e.g. security reasons); most of them available for downloading from the SSM website.

SSM maintains a function on duty around the clock for response to incidents and other urgent matters. In the case of severe events, the emergency organisation will be mobilised. SSM also has one employee available for press contacts and IT support outside office hours.

The annual appropriation directions focus on short-term issues and funding of the Authority's activities. In its appropriation directions for the fiscal year 2014, SSM was for example assigned the following tasks:

- SSM shall report any costs it has incurred for reviewing applications for licences, etc. for the construction of new nuclear reactors. The report shall relate to each individual applicant or licensee. The report must also include an assessment of the possible reduction of fees for individual applicants and licensees for the coming years.
- SSM shall implement a programme of support on safeguards to the International Atomic Energy Agency (IAEA). The cost of the programme is to be reported separately.
- SSM shall review the competence situation within the area of radiation

[11] *The Nuclear Waste Fund is a government authority that manages the fees paid by the power companies and owners of other nuclear facilities in Sweden.*

protection based on the weaknesses identified in the competencies progress report submitted to the Government in 2011. SSM shall report to the Government and submit proposals for action, and if necessary, submit proposals for related financing.

- SSM shall compile the Swedish national report under the Joint Convention on the safety of spent nuclear fuel management and the safety of radioactive waste management for the fifth review meeting. The compilation of the national report should take place as part of appropriate interaction with industry.

SSM's work can be divided into supervision of safety and radiation protection work connected with ionising and non-ionising radiation. As far as concerns ionising radiation, the main regulatory areas are: the use of nuclear technology and power production, the medical sector with therapy and diagnostics, the use of radiation sources and x-ray equipment in industry, the public use of sources and devices in commodities, the use of detectors and scanning equipment for security reasons, the management of radioactive waste, and the exposure to ionising radiation from naturally occurring radioactive material (NORM). In this report, the focus is on supervision of the management of spent nuclear fuel and radioactive waste as defined by the Joint Convention.

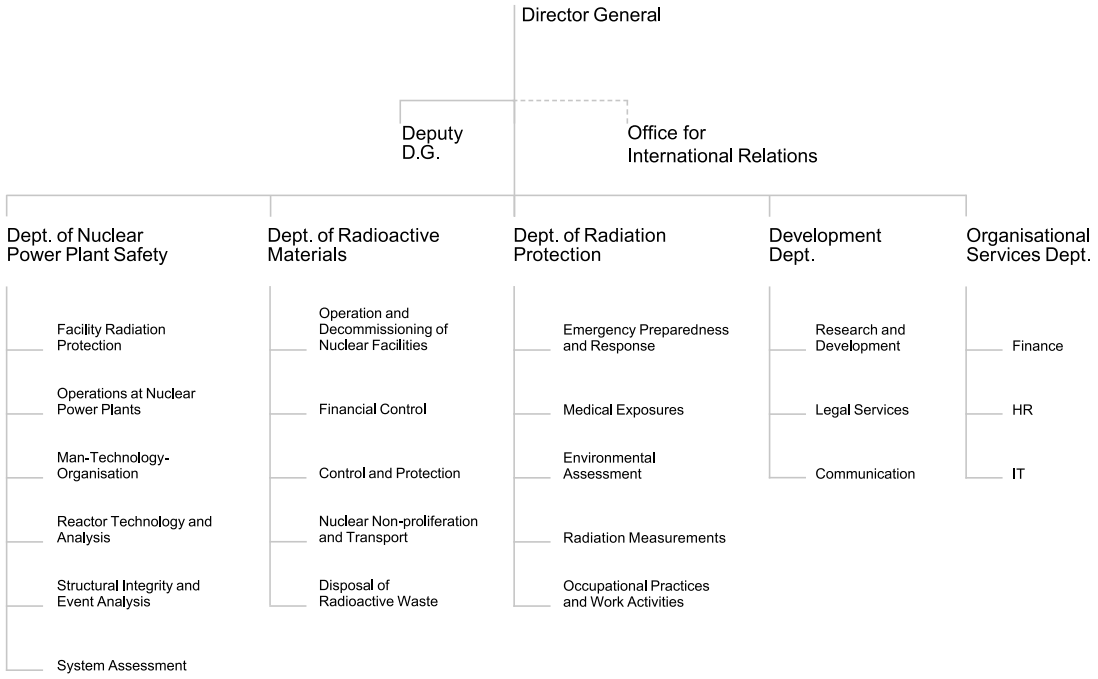

Figure E3: The present organisation of SSM.

With regards to the supervision of spent nuclear fuel and radioactive waste management, the tasks subject to this report are to a large extent carried out by the Department of Radioactive Materials. However, this work is coordinated with the activities of the Department of Nuclear Power Plant Safety (safety issues, human factors expertise and supervision of operating nuclear power plants) and the Department of Radiation Protection (radioactive waste and disused sources from non-nuclear facilities, and emergency preparedness and response).

International development cooperation work is managed by the Office for International Relations, which reports to the deputy DG.

The Director General is exclusively responsible for the Authority's activities and reports directly to the Government. The Authority has an advisory council having a maximum of ten members appointed by the Government. They are usually members of Parliament, agency officials or independent experts. The functions of the council are to advise the Director General and to ensure public transparency (insight) in relation to the Authority's activities, but it has no decision-making powers.

The delegation for financial issues connected with the management of residual products from nuclear activities is an advisory body of SSM for calculating fees to the nuclear waste fund and regarding the amounts of the supplementary guarantees that the utilities must have available. The delegation is led by the Director General and has at most eight other members appointed by the Government and who represent other authorities and independent institutions with relevant competence.

SSM's advisory committee on the safe management of spent fuel and radioactive waste is led by the head of the Department of Radioactive Materials. It has a maximum of eight members representing other authorities and independent institutions with relevant competence, as appointed by the Director General. The advisory committee supports SSM on waste management issues, laws and regulations and in connection with prominent Authority decisions and statements.

SSM also has permanent advisory committees on reactor safety and research and development, as well as in other fields such as UV, EM fields and the use of ionising radiation in oncology.

E.3.1.3 The Swedish Civil Contingencies Agency

The task of the Swedish Civil Contingencies Agency (MSB) is to enhance and support societal capacities for the preparedness for and prevention of emergencies and crises. MSB coordinates emergency preparedness funding, off-site emergency planning and oversees the planning of the regional county administrative boards. MSB also evaluates on-site and off-site emergency exercises and initiates educational efforts.

E.3.1.4 The Swedish Environmental Protection Agency

The Swedish Environmental Protection Agency monitors conditions in the environment and progress in environmental policy. The Agency has the task of coordinating, monitoring and evaluating efforts, involving many agencies, to ensure compliance with the Swedish Environmental Code and to meet the national environmental objectives.

E.3.1.4 The Swedish Work Environment Authority

The Swedish Work Environment Authority's (AV) paramount objective is to reduce the risks of poor health and accidents in the workplace and to improve the work environment in a holistic perspective, i.e. from the points of view of physical, mental and organisational aspects. AV is tasked with (for example) ensuring compliance with work environment legislation.

E.3.1.5 The Swedish National Council for Nuclear Waste

The Swedish National Council for Nuclear Waste is an independent body belonging

to the Ministry of the Environment. The Council's mandate is to study issues relating to nuclear waste and decommissioning of nuclear facilities, and to advise the Government and certain authorities on these issues. Council activities are financed through the Nuclear Waste Fund, as approved by the Government. The members of the Council are independent experts within different areas of importance for the disposal of radioactive waste, not only in technology and science, but also in areas such as ethics and social sciences.

According to its latest Government instructions from April 8, 2009 (Dir.2009:31), the Council shall:

- assess the research and development programme of the Swedish Nuclear Fuel and Waste Management Company (SKB), licence applications and other reports of relevance to the disposal of nuclear waste;
- at the latest 9 months after which SKB, according to Section 12 of the Act on Nuclear Activities (SFS 1984:3), has reported on its RD&D programme, the Council will present an independent assessment of the research and development activities and other measures presented in the RD&D programme. The Council shall also monitor the activities carried out in the area of decommissioning and dismantling of nuclear facilities;
- during the month of February, report on its activities during the preceding year and give its independent assessment of the situation within the area of nuclear waste management;
- investigate and illuminate important issues within the area of nuclear waste management, inter alia through seminars and public hearings, and create the prerequisites for establishing as good a foundation as possible for its advice to the Government;
- monitor the development of other countries' disposal programmes for spent nuclear fuel and radioactive nuclear waste. The Council should also monitor and when necessary participate in the work of international organisations as regards disposal of radioactive nuclear waste and spent nuclear fuel.

E.3.1.6 County administrative boards

The county administrative boards exercise supervision under the Civil Protection Act (SFS 2003:778) and Ordinance (SFS 2003:789) and are responsible for planning and implementing rescue operations in cases where the public needs protection from a radioactive release from a nuclear installation, or in cases where such release seems imminent.

E.3.1.7 The Nuclear Waste Fund

The Nuclear Waste Fund is a government authority whose mission is to receive and manage the fees paid by nuclear power companies and owners of other nuclear facilities in Sweden. The Nuclear Waste Fund makes payments in accordance with SSM's decisions.

The authority has no staff of its own. It is governed by a board of directors representing public service as well as the power plant owners. The board is responsible for maintaining an investment strategy that ensures a good return and satisfactory liquidity. Fund assets must be deposited in an interest-bearing account at the National Debt Office, in treasury bills issued by the state or in covered bonds.

The administration of the Nuclear Waste Fund is managed by the Legal, Financial and Administrative Services Agency.

E.3.2 Human and financial resources at SSM

E.3.2.1 Human Resources

General information

At year-end 2013, SSM had a total of 312 employees. Their average age is 46. Of the employees, 26% are below 40 years of age, 33% are between 40 and 49 years of age, and 41% are 50 years of age or older. Around 14% of SSM employees will reach retirement age (65 years) within five years. However, in Sweden one may opt to work until the age of 67.

In 2013, 58 new employees were recruited (24 women and 34 men) and their average age was 41. The staff turnover rate, excluding retirements, was 4% in 2013, which is normal for a mid-sized technical-scientific competence authority such as SSM. SSM is working on a long-term plan for its competence needs. This work will continue.

The Department of Nuclear Power Plant Safety has (end of 2013) a staff of 93 persons who work with supervision of nuclear safety and radiation protection at the ten nuclear power reactors in operation. Of the 93 staff members, 19% have a postgraduate degree and 68% have a Bachelor's or Master's degree. SSM has designated one inspector for each plant as a 'site coordinator' who serves as the main point of contact between the respective facility and the Authority.

The 70 employees belonging to the Department of Radioactive Materials utilise about 10-12 full-time equivalents on issues of waste management, spent fuels and nuclear non-proliferation towards the operation of nuclear power plants. This department is responsible for inspections of non-power producing nuclear installations (e.g. fuel factory at Västerås, waste treatment and material investigation facilities at Studsvik), decommissioning, financial issues, nuclear security, radioactive wastes and releases from non-nuclear facilities, and planned or existing off-site spent fuel and waste management facilities, including final repositories.

The 73 employees of the Department of Radiation Protection devote some (roughly 20 full-time equivalents) of their resources to national emergency preparedness activities, laboratory measurements, calibrations and use of radiation sources, x-ray equipment, etc. related to the operation of nuclear facilities in Sweden.

Other departments, such as the Development and Organisational Services Departments, and the Office for International Relations, have a total of 76 employees.

The educational background of SSM staff at the end of 2012 is shown in Table E1:

Education	Percentage
Postgraduate degree	21
Bachelor's/Master's	65
Upper secondary school	13
Other	1
Total	100

Table E1: Educational background of SSM staff.

Compared with many other authorities, the staff of SSM have a relatively high level of education. This is a result of the many specialist areas covered by the Authority, and to some extent the fact that there are no dedicated Technical Support Organisations in Sweden to support the regulatory body with specialist knowledge.

In an international comparison, the number of regulatory staff in Sweden is small for the size of the nuclear programme. Many staff members are typically involved in several tasks, such as inspections, regulatory reviews and approval tasks, revision of regulations, handling research contracts and participation in public information activities, with each activity requiring personal expertise. When comparing workforces between different countries, it is nonetheless important to not only count the number of staff members per reactor, but also to consider the types of legal obligations imposed on licensees and the different supervisory practices.

Internal staff training

Competence development was conducted in all departments and units in 2013 and about 1,669 days were used for training (including the supervisory programme described below); this is an average of 5.5 days per employee.

A basic training programme for new employees is provided in the following areas: authority role, occupational health, safety and SSM's core operations. The aim is to foster a deeper understanding of the Authority's activities and to give new employees an important network.

SSM also launched a development programme in skilled supervision in spring 2012. The programme concerns all employees involved in supervisory work at SSM. The aim is for them to have the same basic skills and perform supervision consistently regardless of the supervised entities.

There are plans to further develop employees' supervisory skills at the Authority. Planning involves our exchanging experiences internationally with sister agencies. In 2012 SSM started a general analysis of the Authority in the area of expertise. The purpose of the skills survey is to provide SSM's leadership and managers with a clear picture of the Authority's current skills and, based on this, perform a gap analysis. With this analysis we can determine the skills we need in the short and long term in order to deal with current and future tasks.

During 2013, development efforts were undertaken on the part of SSM's entire management group. This work was based on the skill profiles of identified managers at SSM. Efforts have included both leadership issues as well as issues related to the organisation and systems. During recent years, SSM has conducted about 70 joint agency training sessions in the areas of supervision, preparedness, monitoring, skills exercises and the work environment.

Courses are also given covering the internal processes of the management system, the legal framework for regulatory activities, IT and security routines, project management, inspection methodology, nuclear technology, nuclear power plant and systems courses, as well as media training. For technical training, SSM also uses the licensee training programmes for operations staff, including simulator training. Newly employed SSM staff were also given the opportunity to observe on-site work in a control room over several weeks.

E.3.2.2 SSM's process-based and integrated management system

SSM has an integrated and process-based management system which is certified in the areas of environment, quality management and occupational health and safety

in accordance with the international standards SS-EN ISO 14001:2004, SS-EN ISO 9001:2008 and OHSAS 18001. The management system encompasses all activities of SSM. The system will be supplemented with a section on Information Security following SS-ISO/IEC 27001:2006.

Internal and external audits are performed yearly, which are the basis for continuous improvements to the system. Figure E4 displays SSM's present process scheme. An interactive process model highlighting the sequence and interaction of all key processes has been developed, validated and published on the intranet. Component sub-process information and associated guidance materials can be readily accessed by way of the process model, dedicated intranet pages and a robust document management system. Assigned process ownership applies to the key processes. The process map follows an iterative cycle from left to right: Planning process, Implementation process and the Follow-up process. Various support processes and processing of items of business (registrar, registration and archiving) are grouped below the category Supporting processes.

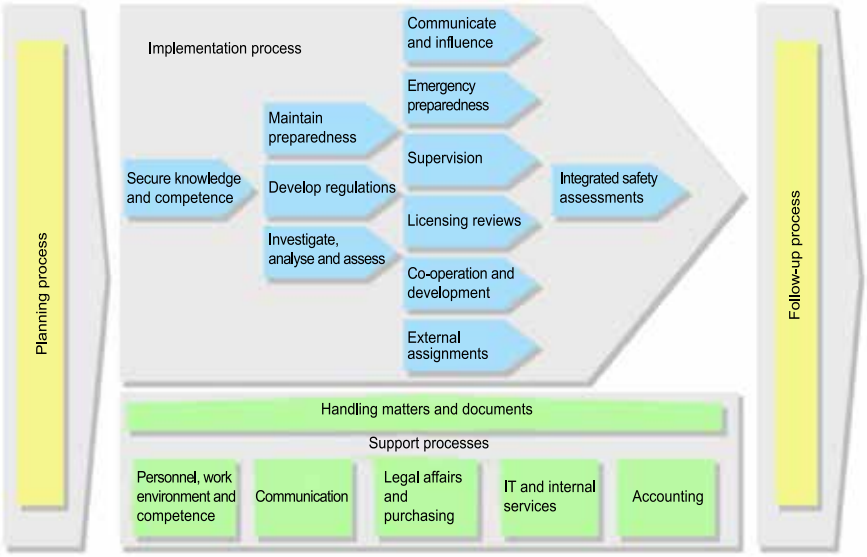

Figure E4: The SSM management system process scheme.

Implementation of audits

SSM ensures that annual internal and external audits of the Authority's activities are carried out, in addition to audits of the Swedish National Audit Office. The SSM management system should account for internal and external requirements; the latter including ISO standards, statutes and legal provisions, e.g. occupational health and safety and information security.

SSM has recently revised the audit programme for 2014-2016. The objective of internal audits is to follow up the activities of the Authority on all levels, to check compliance with external and internal requirements, to investigate how the 'shared values' are integrated in the day-to-day work, and to check if the management system is effective and adapted to its purposes. The internal auditors are appointed by the Director General on the basis of experience, competence and audit objectives.

External audits are carried out every year. In addition to auditing the annual report and finances, the Swedish National Audit office performs checks of the effectiveness of SSM's work. The requirements of ISO 9001, ISO 14001 and OHSAS 18001 and other relevant management system requirements are audited by contracted external auditors. They are accredited by the Swedish Board for Accreditation and Conformity Assessment, an authority under the Ministries for Foreign Affairs and Enterprise, Energy and Communications. The latest external review was carried out in April 2014.

E.3.2.3 Communication

SSM's communication policy, established in April 2009, emphasizes the key values of integrity, reliability and openness while defining their implementation (availability, proactive information, good quality, no unnecessary delay). Other strategy documents, also permeated with the key values, include a communication strategy, a media strategy and an Internet strategy. The crisis communication strategy, established in June 2012, was formed through the experience gained during the accident at the Fukushima Daiichi NPP. The aim of the SSM website is to be transparent and comprehensible, thus giving stakeholders the opportunity to monitor the Authority's work.

E.3.2.4 Financial resources

The regulatory activities of SSM are basically financed through yearly state budget appropriations and reimbursements from the Nuclear Waste Fund, as decided by the Government. The costs of the regulatory activities and related research financed through budget appropriations are largely recovered from the licensees in the form of fees recovered to the state budget. The amounts of the fees are proposed annually by SSM but decided by the Government. The budgets for 2011, 2012 and 2013, including the funding of the separately financed international cooperation and development work, are shown in Table E2.

In addition, some additional resources are from fees for reviewing special applications or licensing work that are paid directly to the Authority. The financial resources of the regulatory body have increased in real terms as compared to what was reported for 2010 in the fifth Swedish national report. The 2013 budget for SSM has been increased further and totals approximately 500 million SEK.

Budget item	2011	2012	2013	Source of funding
Nuclear safety, emergency preparedness and radiation protection (including administration)	232.0	256.6	280.2	Mainly fees
Supervision of nuclear facilities (proportion of above)	97.4	113.3	123.7	Fees
Licensing of new nuclear facilities, including new nuclear reactors	10.4	13.0	45.3	Fees
Scientific research and development work	78.0	73.9	80.3	Mainly fees
Final disposal of radioactive waste, including licensing, financial control and decommissioning	43.1	63.6	70.7	Nuclear Waste Fund
Historical wastes, etc.	0.9	1.3	2.0	Tax funded
Crisis management*	25.0	22.3	6.6	Tax funded
International cooperation and development	47.6	49.6	45.1	Tax funded
Total (million SEK)	436.9	480.3	530.2	

* These funds are received via the Swedish Civil Contingencies Agency (MSB)

Table E2: Budget of SSM in million SEK (1 SEK is about 0.1 euro).

E.3.2.5 Regulatory research and competence support

Based on what is stated about research in the Ordinance (SFS 2008:452) with instructions for the Swedish Radiation Safety Authority, the main purposes of SSM's research are to:

- maintain and develop the competence of importance for radiation protection and nuclear safety work, and
- ensure that SSM has the knowledge and tools needed to carry out effective regulatory and supervisory activities.

SSM supports basic and applied research and also development of methods and processes (usually not products). Just over 4 million euro was directed towards basic research in 2012.

SSM finances a number of research projects and positions at Swedish universities in order to develop and maintain competence and teaching capacity. Central areas are reactor physics, severe accidents and non-proliferation. SSM also financed three higher research posts in radiation biology, radioecology and dosimetry until 2013, two of which have been prolonged by the universities. Research is also financed through open calls in the areas of radiation protection and waste management.

In the context of spent nuclear fuel and radioactive waste management, SSM initiates research and review assignments in a broad range of areas. Examples of areas are copper corrosion, biosphere modelling, rock mechanics, spent fuel nuclide chemistry, glaciology, decommissioning and non-proliferation. However, research related to spent fuel management has long been predominant. Because Sweden has no TSO (Technical Support Organization), many national and international universities, institutes and consulting companies are engaged in research and review within areas connected to spent fuel management.

Over the past three decades, SSM and its predecessors have been carrying out an extensive research programme with the aim of developing independent competence and tools for the licensing reviews of geological repositories. The research has been carried out by the authorities' own staff and by a network of external experts, and has included several international initiatives in the areas of hydrogeology (e.g. Intracoin and Hydrocoin), model validation (e.g. Intraval), radionuclide transport, rock mechanics modelling (e.g. Decovalex), biosphere modelling (e.g. BIOMOVS) and protection of the environment (the European Commission FASSET and Erica projects). The former authority, the Swedish Nuclear Power Inspectorate, also carried out two independent safety assessments of the KBS-3 method for disposal of spent nuclear fuel (Project-90 and SKI Site-94).

In addition to the more technical research programme, Swedish regulators have also carried out a research programme on stakeholder dialogue together with environmental organisations, other non-governmental organisations and the municipalities involved in SKB's programme for siting a spent nuclear fuel repository (e.g. the RISCOM I and the European Commission Riscom II projects). These projects have contributed to developing methods and fora for stakeholder dialogue and a better understanding of the roles and needs of different actors.

Since the Swedish Nuclear Fuel and Waste Management Company (SKB) submitted its licence application for a spent fuel repository in 2011, SSM has been reviewing the application with support from external experts. Most of this support focuses on post-closure safety. Approximately 25 contractors have been procured

and about 70% of these are international. So far the external assessment has resulted in about 50 Technical Notes that are available at SSM's website *www.ssm.se*.

During the early 2000s the yearly budget for research in the waste management area varied between 1.5 and 2 million euro. In 2012 there was a shift from research to external review support: the yearly expenditure for research dropped to around 0.5 million euro and the expenditure for external review support has remained around 1.0 and 1.6 million euro.

E.3.3 Independence of regulatory function

The *de jure and de facto* independence from political pressure and promotional interests is well provided for in Sweden. The laws governing SSM concentrate solely on nuclear safety and radiation protection (also security, physical protection and non-proliferation, but outside of the scope addressed in this convention). SSM reports to the Ministry of the Environment, which is not involved in the promotion or utilization of nuclear energy. The Ministry of Enterprise, Energy and Communications is responsible for energy policy and the Ministry of Finance represents the Government's ownership in Vattenfall AB (the owner of seven nuclear power reactors in Sweden).

An individual minister cannot interfere with the decision making of a government agency according to fundamental Swedish law. This is a matter for the Government, in plenum.

E.3.4 Action to improve transparency in regulatory activities and communication with the public

According to the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452), SSM shall by means of communication and transparency contribute towards public insight into all operations encompassed by the Authority's mandate. The aim of this work shall for example be to provide advice and information about radiation, its properties and areas of application and about radiation protection.

SSM publishes all its significant decisions on the SSM website. Through an e-register on the website, the general public can view the documents sent from the Authority or submitted to it. The Constitution gives everyone the right to access the documents held by the Authority. This does not apply to documents subject to confidentiality due to e.g. safety aspects or other specified reasons. The Authority provides documents not subject to confidentiality upon request from the general public and journalists.

Before regulations can be issued, the financial and administrative implications for the companies concerned must be examined. An important aim of this analysis is that the requirements in the regulations must be justified, and not unnecessarily increase costs or the administrative burden for the operators. For this reason, SSM always communicates drafts through a referral process to obtain opinions on these and other aspects of the proposed regulations.

Before the application was submitted for a final repository for spent nuclear fuel, SSM participated in numerous meetings between the applicant, the affected municipalities, the public and NGOs. The purpose of this involvement was to provide information about the Authority's activities and missions, as well as function, in the examination of the application. These meetings took place in the context of the Environmental Impact Assessments (EIA).

SSM is currently participating in the EIA consultation regarding the planned expansion of the final repository for low and intermediate level waste (SFR) in Forsmark.

E.3.5 Conclusion

Sweden complies with the obligations of Article 20.

F.1 Article 21: RESPONSIBILITY OF THE LICENCE HOLDER

1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.
2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.

F.1.1 Regulatory requirements

F.1.1.1 The prime responsibility

According to the Act on Nuclear Activities and the Environmental Code, a party that holds a licence for nuclear activities shall be responsible for ensuring that all the necessary measures are taken for:

- maintaining safety, taking into account the nature of the operation and the circumstances in which it is conducted,
- safe management and disposal of nuclear waste generated by the operation or nuclear material derived from the operation that is not reused, and
- safe decommissioning and dismantling of facilities in which the operation shall be discontinued until such date that all operations at the facilities have ceased and all nuclear material and nuclear waste have been placed in a disposal facility that has been sealed permanently.

According to the Radiation Protection Act and the Environmental Code, parties conducting activities involving radiation shall, while taking into account the nature of the activity and the conditions under which it is conducted:

- take the measures and precautions necessary to prevent or counteract injury to people and animals and damage to the environment,
- supervise and maintain the radiation protection at the site, on the premises and in other areas where radiation occurs, and
- properly maintain technical devices and monitoring and radiation protection equipment used in the activity.

In the Governmental Bills to the Acts, it is also underlined that the licensee shall not only take measures to maintain safety and radiation protection, but also measures to improve these protective measures where this is justified.

The Swedish Radiation Safety Authority's (SSM) Regulations on Safety in Nuclear Facilities (SSMFS 2008:1) specify the responsibility of the licensee through a number of functional requirements on safety management, design and construction, safety analysis and review, operations, nuclear materials/waste management and documentation/archiving. In addition it is clearly pointed out in these regulations that safety shall be monitored and followed up by the licensee on

a routine basis, and deviations identified and corrected so that safety is maintained and further developed according to valid objectives and strategies.

The continuous preventive safety work required includes reassessments, analysis of events in one's own and other facilities, and analysis of relevant new safety standards, practices and research results. Any reasonable measure useful for safety shall be taken as a result of this proactive and continuous safety work and be documented in a safety programme that is to be updated annually.

The basic safety documentation (Safety Analysis Report, SAR, including Operational Limits and Conditions, plans for emergency response and physical protection) must be formally approved by SSM. Plant and organisational modifications and changes in the safety documentation are to be notified and SSM can, if needed, impose additional conditions and requirements. All other issues are dealt with as part of licensee self-assessments. SSM examines how this liability is managed.

According to SSM's Regulations Concerning Basic Provisions for the Protection of Workers and the General Public in Practices Involving Ionising Radiation (SSMFS 2008:51), anyone who conducts activities with ionising radiation must ensure that the practice is justified. By this it is meant that the use of radiation should give a benefit exceeding the estimated health detriment caused by the radiation. The radiation protection measures shall be optimized, meaning that human exposures are as low as reasonably achievable, while taking into account societal and economic factors and no dose limit in these regulations is to be exceeded. These basic radiation protection principles also apply to waste management and disposal as regulated in SSM's Regulations Concerning the Protection of Human Health and the Environment in Connection with the Final Management of Spent Nuclear Fuel and Nuclear Waste (SSMFS 2008:37).

The optimisation and use of the best available technique (BAT) also apply to discharges to the environment during the normal operation of nuclear facilities. This is regulated in Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities (SSMFS 2008:23).

SSM shall ensure that regulations and procedures used are cost effective and useful for individuals as well as companies. They must be written and designed so that the regulatory body does not take over the prime responsibility for safety and radiation protection.

The supervision that SSM carries out shall ensure that the licensees operate the activity in a safe way and while maintaining radiation protection.

F.1.1.2 The ultimate responsibility

The State has an overall responsibility for activities regulated in the Act on Nuclear Activities. However, this ultimate responsibility has not been explicitly expressed in the legislation, but through Government statements. Therefore, clarification of the State's responsibility has therefore been considered necessary in the legislation. In 2011 a Committee of Inquiry proposed to establish a rule of law that regulates the Government's ultimate responsibility for spent nuclear fuel. The proposal is under consideration by the Ministry of the Environment.

F.2 Article 22: HUMAN AND FINANCIAL RESOURCES

Each Contracting Party shall take the appropriate steps to ensure that:
(i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and a radioactive waste management facility;
(ii) adequate financial resources are available to support the safety of facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;
(iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

F.2.1 Regulatory requirements

F.2.1.1 Qualified staff during the operating lifetime

The general safety regulations concerning safety in nuclear facilities (SSMFS 2008:1) are specific about the staffing of nuclear facilities. Long term planning is required of the licensees in order to ensure that they have enough staff with sufficient competence for all safety-related tasks. A systematic approach should be used for the definition of the different competences needed as well as the planning and evaluation of all safety-related training. It is also a requirement to have a balance between the use of in-house personnel and contractors for safety-related tasks. The competence necessary for ordering, managing and evaluating the results of contracted work should always be present within the organisation of a nuclear installation.

The regulations also contain provisions stipulating that the staff must be fit for their duties. This implies medical requirements and drug testing, etc. Such provisions have not been issued previously. How licensees manage fitness for duty issues has, however, been monitored through inspections.

F.2.1.2 Adequate human and financial resources

During operation and decommissioning
It is clear from the Swedish Act on Nuclear Activities that in order to obtain a licence, financial resources must be committed in order to manage the safety obligations mentioned in Chapter 10 of the Act. Each prospective licensee must be assessed in this respect during the licensing procedure.

Provision for financial resources during decommissioning is provided by means of investments in government-controlled funds. Licensees of nuclear facilities must pay a fee to the Nuclear Waste Fund according to the Act (2006:647) on Financial Measures for the Management of Residual Products from Nuclear Activities, as described in section E.2.2.5. This is to ensure the financing of decommissioning and handling and disposal of spent fuel and nuclear waste, including the research needed for these activities.

The disposal facility for radioactive operational waste (SFR) has been paid for directly by the nuclear power utilities and not by the Fund. Operational waste is not covered by the Act on Financial Measures for the Management of Residual Products from Nuclear Activities, but is instead paid for by the nuclear power utilities at the time the waste is produced.

Provisions for institutional control and monitoring after closure
As described in section F.6.1.1, the holder of a licence for nuclear activities shall be responsible for ensuring that all measures are taken that are needed for the safe decommissioning and dismantling of plants in which nuclear activities are no longer to be conducted. Post-closure institutional control and monitoring is not required in the Swedish management system for spent fuel and radioactive waste. It follows that a licensee may be exempted from its responsibilities when decommissioning and dismantling have taken place and that financial provisions for institutional control and monitoring after closure are not required.

The State has an overall responsibility for activities regulated in the Act (1984:3) on Nuclear Activities. It follows that the State would be responsible for the arrangements and costs of any institutional control or monitoring possibly conducted after the licensee has been exempted from its responsibilities.

F.2.2 Measures taken by the licence holders

F.2.2.1 Qualified staff during the operating lifetime

New facilities are planned to be built and put into operation in the near future. Therefore the implementer, SKB, needs to ensure and broaden the competence concerning the operation of nuclear facilities. Important steps in that direction were taken when SKB took over the operation of Clab in January 2007 and the operation of SFR in July 2009, which were previously contracted out to OKG and FKA, respectively.

F.2.2.2 Adequate human and financial resources

As described in the introduction, the nuclear power utilities have formed a jointly owned company, the Swedish Nuclear Fuel and Waste Management Company (SKB), to fulfil their obligations regarding spent fuel and radioactive waste management. SKB is assigned by the nuclear utilities to make their cost estimates forming the basis for calculating the fee that the licensees of nuclear power plants must pay to the Nuclear Waste Fund.

The nuclear power plant licensees also make two types of guarantees available to the government in the event that the Nuclear Waste Fund should prove to be inadequate. The two types of guarantees serve different purposes, see section E.2.2.5.

F.2.3 Regulatory control

Qualified staff during operation
The compliance with the requirements on competence assurance has been inspected a few times since SKB took over the operation of Clab and SFR. The regulatory authority has concluded that the required systematic approaches are in place to ensure long term staffing and competence of operations staff.

SKB introduced during 2011–2012 a competence support system, Competence Tool (CT), to develop competence assurance within the organisation. Furthermore, SKB has reinforced the staffing of human factors specialists. However, SSM has observed a further need for SKB to enhance the management of the evaluation of results of work being conducted by contractors.

Adequate financial resources

The regulatory authority assigned by the Government, SSM, reviews the licensees' cost estimates according to the Act on Financial Measures for the Management of Residual Products from Nuclear Activities. Furthermore, SSM reviews the extent of the guarantee that the licensees must make available to ensure that the financing system will be able to meet future needs. After its review of the nuclear power utilities' cost estimates, SSM submits a proposal on the amount of the fees, and the extent of the guarantees required, to the Government. Based on this proposal, the Government sets the fees and guarantees. For licensees of nuclear facilities other than nuclear power reactors, SSM sets the fees and guarantees for the following three years after reviewing cost estimates submitted by the licensee.

The reimbursements to SKB are decided on by SSM and the Nuclear Waste Fund makes the payments in accordance with SSM's decisions.

F.2.4 Conclusion

Sweden complies with the obligations of Article 22.

F.3 Article 23: QUALITY ASSURANCE

Each Contracting Party shall take the necessary steps to ensure that appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.

F.3.1 Regulatory requirements

The general safety regulations SSMFS 2008:1 (Chapter 2, Section 8) require that nuclear activities, design, construction, operation and decommissioning shall be managed, controlled, assessed and developed through a management system so designed that requirements on safety are met. The management system including the needed routines and procedures must be kept up to date and be documented. This view on quality and safety, to be integrated with other business concerns into an integrated management system, is in line with the recently issued IAEA Safety Standards Series No. GS-R-3 (The Management System for Facilities and Activities).

It is further required in regulations that the application of the management system and its efficiency and effectiveness must be systematically and periodically audited by a function having an independent position in relation to the activities being audited. An established audit programme must be in place at the nuclear facility.

In the general advice to the regulations it is made clear that the management system should cover all nuclear activities at the facility. Furthermore, it should be clear from the management system how to audit contractors and vendors, and how to keep results from these audits up to date.

The internal audit function should have a sufficiently strong and independent position in the organisation and report to the highest manager of the facility. The audits should have continuity and auditors should have good knowledge about activities being audited.

Audit intervals should take into account the importance for safety of the different activities and special needs that can arise. Normally all audit areas should be covered every four years as a minimum.

The auditing activity itself and the management function of the plant should also be audited periodically.

F3.2 Measures taken by the licence holders

F.3.2.1 Quality programmes – NPPs

In Sweden the general description of the quality and management system is normally regarded as the plant's most important document, as it gives an overview of the requirements and the way in which the organisation is supposed to work in order to meet these demands. The documents are to be kept available for everyone in the plant organisation, and also for others who are affected by the information in the documents, for instance contractors, consultants and regulatory authorities. All

documents in the quality and management system are under controlled revision, regularly or when needed, in order to reflect the actual situation at the plant at all times.

Development of quality assurance programmes at Swedish NPPs began in the late 1970s. These programmes have since then been developed continuously over the years, and have obviously been affected by regulations and expectations from the regulatory body and business associates. In the beginning, the quality manuals of the NPPs were limited to descriptions of routines in a number of functional areas, but they lacked clear statements of the objectives and requirements. During the 1990s there was considerable development of the concept, and the quality assurance programmes of Swedish NPPs are today integrated in the total management system of every plant.

The main principles are the same for the quality and management systems of the Swedish NPPs, with documents on three levels. The first level (top-level) documents are issued by the plant director. The top-level documents typically include a vision to strive for, a business concept that outlines the mission of the facility, objectives for different areas and strategies to accomplish the objectives.

Objectives are typically defined for:
- nuclear safety,
- occupational safety,
- economic results,
- confidence from society,
- environmental impact, and
- personnel responsibility.

A comprehensive description of the organisation with responsibilities for functions and processes, division of responsibility and management principles is also included in the top-level documents. Furthermore, there are policies, conditions and directives for the main activity processes at the plant. In the conditions all the legal requirements are included, as well as the plant owners' requirements and additions. Finally the top-level documents include directives to all departments and staff units at the power plant.

The second-level documents of the management system contain commitments from the responsible managers on how to work with the tasks delegated by the plant director in the top-level documents. These replies are given as objectives, directives, process descriptions and instructions for the different areas of responsibility.

The third-level documents include instructions for specific activities and tasks included in the different areas of responsibility as defined by the second-level documents.

In addition to the three levels of documents, there can also be various types of administrative handbooks.

The purpose of the quality and management system is to achieve a unified and consistent control system for all plant activities based on clear policies and measurable objectives. There should be complete traceability from policy to work instruction.

The standard ISO 9001:2000 for quality management systems leads to more emphasis on processes and attempts to implement process orientation in the organisation and daily work.

F.3.2.2 Quality programmes – SKB

The management system of SKB consists of a number of steering documents, see Figure F1, divided on overall company level (blue part) and an operational level (beige part). An explanation of the hierarchy and definitions of policy, guideline, routine and instruction are provided below.

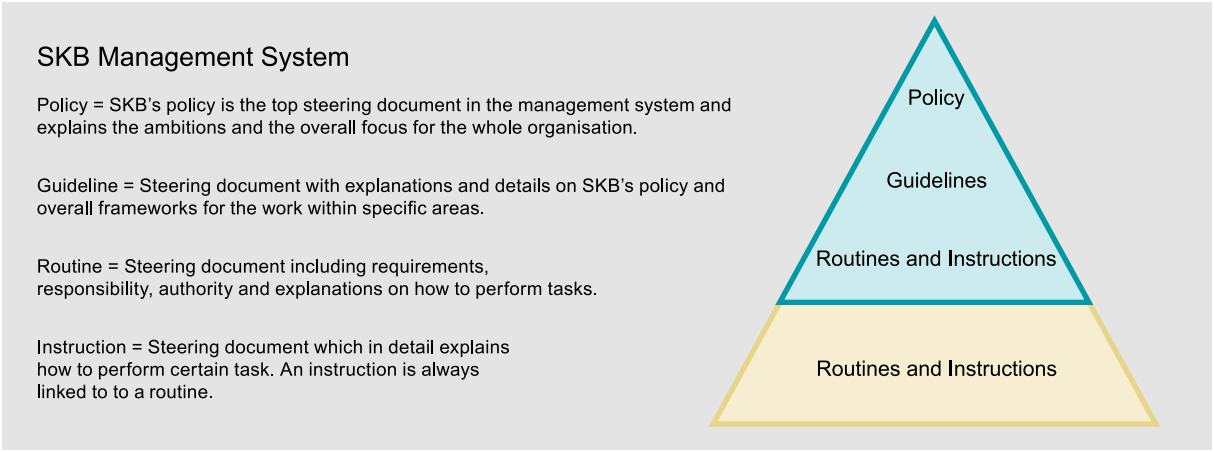

Figure F1: SKB's Management System.

F.3.2.3 Quality system implementation and quality audit programmes

All Swedish nuclear power plant licensees and SKB have developed a quality audit programme which is used to monitor how well the quality system is implemented and applied in the organisation on different levels, as well as the efficiency of the system to ensure quality and safety. Being responsible for the long-term safety of SFR, SKB also reviews all NPP utilities with regard to fulfilment of regulatory requirements concerning waste generation and conditioning.

F.3.2.4 Quality audits of suppliers

According to the requirements on quality assurance in the general regulations SSMFS 2008:1, all purchases of goods and services which might have an effect, directly or indirectly, on the protection and safety of the environment or personnel, shall be made from suppliers that through quality audits, or in other ways, have shown that they can comply with quality requirements.

The ambition of the licensees is not limited to these demands, but also includes suppliers of goods and services, where malfunctioning might cause considerable consequences for the operation. A review of a supplier includes not only a quality audit, but also a technical and commercial evaluation of the equipment or services offered. As of 1998 a review of the supplier's environmental management system is included in the review. These aspects will, however, not be covered in this report. The purpose of a quality audit of a potential supplier is not only to evaluate whether the supplier has implemented and uses a documented quality system, but also to evaluate the supplier's capability of providing the correct and expected quality. Quality audits are typically performed by teams of 1-4 auditors. The audit team is to be led by a person with documented knowledge and experience in the QA area and of the quality norms. The team leader shall have experience from participation in se-

veral quality audits. The team shall comprise one or more persons with competence or experience from the product or service to be reviewed. Thus, there is no formal licensing of audit team leaders and team members for Swedish nuclear facilities.

A quality audit results in a report, which must be accepted by the company reviewed, before being presented to the purchasing organisation. If deficiencies are revealed during the audit, the organisation under review is requested to describe what measures will be taken to correct the deficiencies in order to be accepted as a supplier of products or services to the organisation. In certain cases a follow-up visit of the audited company is required to verify that the company has taken the actions.

Approved quality audits accomplished by any of the other Swedish NPPs are normally considered comparable with a plant's own quality audits and, consequently, audit duplications of a given supplier can be avoided. Simplified quality audits or evaluation of previous experience of a supplier are sometimes acceptable when purchasing goods and services dedicated for use in the lower quality classes.

F.3.3 Regulatory control

SSM's own quality system includes guidance for SSM staff when reviewing the licensees' quality systems. Usually the quality system itself is not the only target for SSM's review and inspections. Appropriate aspects of the application of quality assurance are included in all SSM's regulatory inspections. Thus, during inspections, routines and instructions are studied, as well as how they are enforced in practice in order to control safety-related activities. The licensees' plans for quality audits and the reports from performed audits have also been subject to review by SSM.

In general SSM has been satisfied with the implementation of quality assurance. SSM has found that in general the management system has been implemented and applied on all levels of the organisation. The plans for and implementation of quality audits have also been found to be acceptable. However, regulatory experience shows the necessity of having a living quality audit programme at the facilities and using the audits to develop quality and safety, making sure to cover all areas and activities and with sufficient traceability. This means that the audits should not only investigate compliance with the documented routines, but also the suitability and efficiency of the routines in line with the concept of a learning organisation.

F.3.4 Conclusion

Sweden complies with the obligations of Article 23.

F.4 Article 24: OPERATIONAL RADIATION PROTECTION

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:
   (i) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable, economic and social factors being taken into account;
   (ii) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection; and
   (iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.
2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:
   (iv) to keep exposure to radiation as low as reasonably achievable, economic and social factors being taken into account; and
   (v) so that no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitation which have due regard to internationally endorsed standards on radiation protection.
3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

F.4.1 Regulatory requirements

In order to regulate and create a basis for effective supervision of radiation protection at nuclear facilities, including those for management of spent nuclear fuel and radioactive waste, basic radiation protection requirements are laid down in a number of SSM regulations.

In order to regulate and create a basis for effective supervision of radiation protection at nuclear facilities, including those for management of spent nuclear fuel and radioactive waste, basic radiation protection requirements are laid down in a number of SSM regulations.

F.4.1.1 Regulatory requirements on occupational radiation protection

Swedish occupational radiation protection requirements aimed at nuclear facilities are similar to those of other EU Member States since they follow the binding requirements of the Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the health protection of the general public and

workers against the dangers of ionising radiation. The principal provisions as regards occupational radiation protection are found in the SSM regulations SSMFS 2008:24, SSMFS 2008:26, SSMFS 2008:51 and SSMFS 2008:52, accounted for in section E.2.2.3. These regulations are currently under revision in order to comply with the new requirements of the Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation. The most important provisions in the context of the Joint Convention are summarized below.

General Requirements and dose limits

Anyone who conducts an activity with ionising radiation shall ensure:

1. Justification: The activity is justified, by which means that the use of radiation gives a benefit to individuals and to society that outweighs the harm including radiation detriment.
2. Optimisation: The radiation protection measures are optimised, by which is meant that exposures, and the probability and magnitude of potential exposures and the number of exposed, are kept as low as reasonably achievable, while having taken into account technical, economic and societal factors.
3. Dose limitation: The activity is carried out in such a way that no radiation dose limits are exceeded.

Optimisation

Anyone who conducts a practice with ionising radiation shall ensure that the radiation protection measures are optimised and that no radiation dose limit is exceeded. The licensee shall ensure that documented goals and actions for the optimisation work are established and that the necessary resources are available in order to perform the actions and work towards the established goals.

Dose limits for workers

The limit for a worker regarding effective dose is 50 mSv in a calendar year, with the additional constraint that the integrated effective dose over five consecutive years must not exceed 100 mSv. The equivalent dose limit to the lens of the eye and to skin, hands and feet is 150 mSv and 500 mSv in a year, respectively. Lower limits apply for apprentices and special rights for rearrangements at work apply to breastfeeding and pregnant women. Additional requirements ensure that the dose to a foetus does not exceed 1 mSv for the remaining period of a pregnancy. Data on intakes and individual radiation doses is kept in the national dose register. Dose records are saved until a person has reached the age of 75, and at least until 30 years after work with ionising radiation has ceased.

Medical examination

A worker must each year arrange for a new doctor's certificate as proof of that he or she is fit for service. At least every third year, this must be based on a full medical examination by a doctor.

Supervised and controlled areas

Zoning of the workplace and a division into supervised and controlled areas are required. Areas must be marked and radiological information given (dose rates, sources, contamination levels, entrance restrictions, etc.).

If there is a risk of spreading contamination or the annual effective dose might exceed 6 mSv, the workplace shall be classified as a controlled area. Access is then more restricted, protective clothing and personal protection equipment might be mandatory, specific information/education is required and a personal dosimeter must be worn. Within a controlled area, premises shall be specially marked and admittance restricted (locked with special keys) if the risk of receiving an annual effective dose of more than 50 mSv is non-negligible.

Visitors
Visitors are allowed if guided by designated persons and a strict, prearranged visit plan is followed. No high-dose rates areas may be visited.

Information and education
All personnel, permanent staff and contractors, shall be informed about radiation risks and have proper education prior to working within a controlled area. The training shall be adjusted to the scope and type of the work to be performed and to the existing radiological working environment.

Site-specific instructions, radiation protection expert
The licence holder shall ensure that site-specific instructions for radiation protection are established. The licensee shall also appoint a radiation protection expert. This person shall be approved by SSM and have sufficient competence in matters related to radiation protection to be able to promote active radiation protection work and to check on the implementation of the radiation protection legislation.

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

Policy in the event of fuel failures
A documented policy with a strategy for avoiding fuel failures and managing fuel failures if they occur is mandatory. The aim is to minimize the negative radiological impact of radiation doses to workers and the public.

Reporting
Annual reports describing the radiation protection work, the progress and evaluation of the optimisation work, and experience from outages are required. In the case of an accident or events that led or could have led to the spread of contamination or high doses, rapid communication to the regulatory body is required. Various other reports are required. The radiation protection expert oversees timely and accurate reporting.

F.4.1.2 Regulatory requirements on environmental radiation protection

The Swedish Radiation Safety Authority's regulations (SSMFS 2008:23) concerning the protection of human health and the environment from discharges of radioactive substances from certain nuclear facilities apply to nuclear facilities under normal operations and are described in section E.2.2.3. The most important provisions are described below.

Public dose limits, dose constraints and critical group
The effective dose limit for members of the public is 1 mSv per year. A dose constraint for the discharges of radioactive substances to water and air (authorized releases) is set to 0.1 mSv per year and site including all nuclear facilities located at that site. The dose constraint is subject to comparison with the calculated dose to the most exposed individual (critical group). The dose models used are approved by SSM.

The 0.1 mSv dose constraint is compared with the sum of a) the effective dose from the annual external exposure, and b) the committed effective dose resulting from a yearly discharge. A 50-year integration period is used for the committed effective dose. If the calculated sum dose exceeds 0.01 mSv per year, realistic calculations of the individual radiation doses, using measured dispersion data, food habits, etc., shall be made for the most affected area.

Discharge limits
The discharge limit is achieved through the restriction of the radiation dose to the critical group. Sweden has no legal nuclide-specific discharge limits.

Optimisation and Best Possible Technology
Limitation of releases shall be based on optimisation of radiation protection and by using the Best Possible Technology (BAT).

Release monitoring
The release of radioactive substances shall be measured. All non-monitored releases shall be investigated and an upper boundary for possible undetectable leakage to air and water from each facility shall be set.

Releases via the main stacks of nuclear power reactors shall be controlled by continuous nuclide-specific measurements of volatile radioactive substances such as noble gases, continuous collection of samples of iodine and particle-bound radioactive substances, as well as measurements of carbon-14 and tritium.

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

Controls and testing
The function and efficiency of measurement equipment and release limiting systems shall be checked periodically and whenever there are any indications of malfunctions.

Environmental monitoring
Environmental monitoring in the areas surrounding nuclear facilities shall be performed according to monitoring programmes determined by SSM. The programmes specify the type and sampling frequency, sample treatment, radionuclides to consider, reporting, etc. The Swedish Agency for Marine and Water Management performs sampling at and outside the facilities. Samples are analysed by the nuclear facilities or by external laboratories that have adequate quality assurance systems. To verify compliance, SSM performs inspections and takes random subsamples for control measurements at SSM or at other independent laboratories.

Reporting
The nuclear reactor licensees report annually to SSM on adopted or planned measures to limit radioactive releases with the aim of achieving their specified target values. If established reference values are exceeded, the planned measures to achieve the reference values shall be reported. Releases of radioactive substances to the air and water as well as results from environmental monitoring shall be reported twice a year to SSM. Events that lead to an increase in releases of radioactive substances from a nuclear facility shall be reported to SSM as soon as possible, together with a description of the actions taken to reduce the releases.

F.4.1.3 Protection of the environment

Protection of the environment has long been included in the aims of international and Swedish recommendations and regulations. The first section of the Swedish Radiation Protection Act (1988:220) states that "The aim of this Act is to protect people, animals and the environment against harmful effects of radiation". However, specific requirements regarding protection of the environment are still in an evolving stage. Recent international development can for example be seen in the revised IAEA Basic Safety Standards, which are "designed to identify the protection of the environment as an issue necessitating assessment" (point 1.3.5) as well as in the new EU BSS which "calls for a policy protecting the environment against the harmful effects of ionising radiation" where "environmental criteria based on internationally recognised scientific data […] should be taken into account" (point 27 in the introduction).

Requirements in Swedish legislation regarding protection of the environment are currently found in SSMFS 2008:37, the Swedish Radiation Safety Authority's Regulations Concerning the Protection of Human Health and the Environment in Connection with the Final Management of Spent Nuclear Fuel and Nuclear Waste. These regulations specify "protection of the environment" as protection of biodiversity and the sustainable use of biological resources, and require an assessment to be performed describing biological effects in habitats and ecosystems, and thereby demonstrating that the environment is protected. Similar requirements were included in the draft revision of SSMFS 2008:23, the Swedish Radiation Safety Authority's Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities. This revision is now paused while awaiting a broader revision of several SSM regulations, but a similar requirement will most likely be included in the final revision as well. This type of requirement has also been communicated with ESS AB as part of its licence application to build the European Spallation Source Facility in Sweden, and will most likely be included in the licence conditions for this facility if a licence is granted.

In response to this type of requirement on demonstration of protection of the environment, several assessments have been conducted and submitted to SSM as part of the licence applications for the spent nuclear fuel repository and the European Spallation Source. The general methodology for these assessments follows the ERICA integrated approach and screening values which were developed during a series of EU research projects (FASSET, ERICA, PROTECT). In brief, chronic activity concentrations in environmental media (air, soil, water and organisms) are calculated from a release rate and transfer parameters. The ERICA Tool can then be used to estimate internal and external dose rates to organisms assuming

homogenous distribution of radionuclides in organisms of simple ellipsoid shapes. These dose rates are then primarily compared to a screening dose rate so that situations involving dose rates lower than this screening value could confidently be judged as being of no regulatory concern.

The regulatory control within the area of environmental protection against ionising radiation is currently mainly achieved through SSM's reviews of licence applications. In addition to a formal check that an assessment has been performed in order to describe biological effect and thus demonstrate that biodiversity and the sustainable use of biological resources are protected, the assessment is reviewed so as to assess the relevance, completeness and quality of the assessment in order to ensure that it indeed demonstrates that the environment is not put at risk if the licence is granted. Future inspections of licence holders, e.g. inspections of nuclear power plants when the revised regulations awaited are in place, will also enforce that existing environmental risk assessments are updated to match the international evolution within the area of environmental protection against ionising radiation.

F.4.2 Radiation impact of spent nuclear fuel or radioactive waste management facilities

F.4.2.1 Occupational radiation doses

In general both individual and collective doses from radioactive waste handling at nuclear power plants are low compared to doses from normal operation, maintenance and service work performed in connection with outages. Nevertheless it is important that the working methods are carefully planned and in compliance with the existing regulatory requirements, see section F.4.1.1, to ensure that occupational radiation protection is optimized.

In this section, examples of occupational doses received at spent fuel and radioactive waste management facilities are presented. Personnel working with radioactive waste at the nuclear power plants are exposed to annual doses in the order of a few mSv. The annual collective doses at the nuclear power plants to this category of workers are normally in the order of 10-20 mmanSv.

At the central interim storage facility for spent nuclear fuel (Clab), doses are obtained from normal operation involving receiving, unloading and cleaning the transport containers. In addition, maintenance and service of Clab's internal lifting and handling equipment as well as the water cleaning system give radiation doses. The work doses to the personnel at Clab reported between 2007 and 2013 are shown in Figure F2.

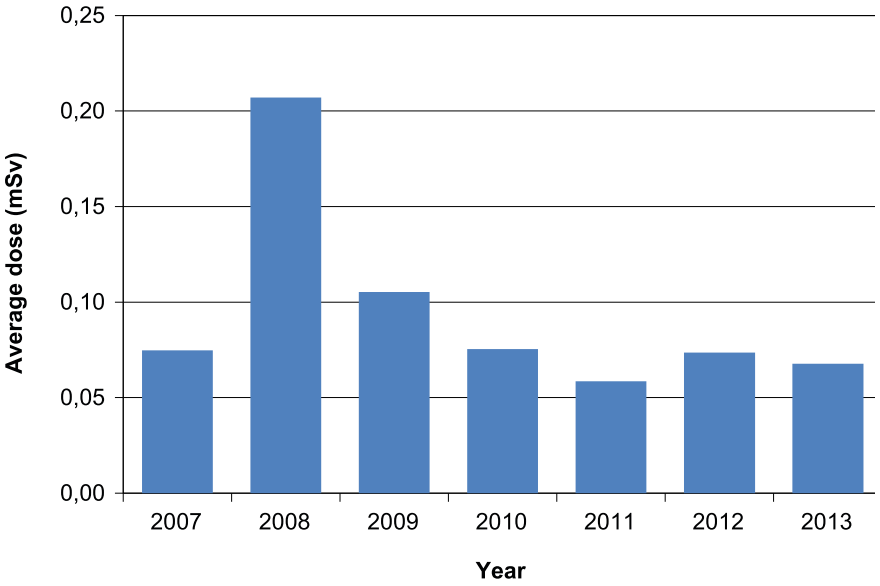

Figure F2: Average doses (mSv) to the personnel at Clab 2007-2013.

No open radiation sources are handled at the disposal facility for low and intermediate level waste (SFR) and all radioactive waste is conditioned. Thus, the doses to the personnel originate only from external radiation. Contamination of transport casks and waste packages has never occurred to the extent that any airborne radioactivity has been measured or reported. There are some variations depending upon whether or not waste packages were covered with concrete during the year. The yearly doses to the personnel at SFR are very low, so low that they are barely measurable. Studsvik operates several facilities for treatment of radioactive waste. For 2013 Studsvik reported an average individual effective dose of 0.39 mSv. For staff working with waste management at the fuel factory Westinghouse Electric Sweden AB, annual individual doses are below 1 mSv.

F.4.2.2 Radiation doses from releases of radioactive substances

Figure F3 displays the estimated effective dose to the representative person ("critical group") from the releases of radioactive substances at major Swedish nuclear facilities for the years 2007-2013. The resulting estimated effective doses are less than 1% of the stipulated dose constraint of 0.1 mSv at all the Swedish sites. From the available release data, it is not possible to single out releases from radioactive waste management at the NPPs.

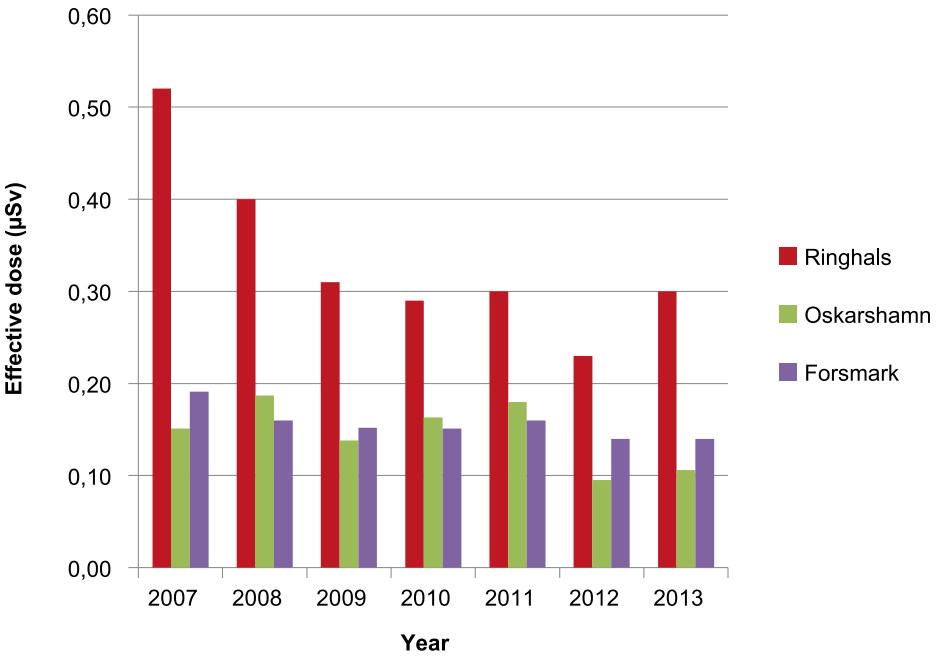

Figure F3: Effective dose (µSv) to the representative person in the critical group.

The releases of radioactive substances from Clab, SFR and Ranstad Mineral are very small as shown in Figure F4 below (the licence for extraction of uranium from waste at Ranstad Mineral expired in December 2009, see section F.6.2.4).

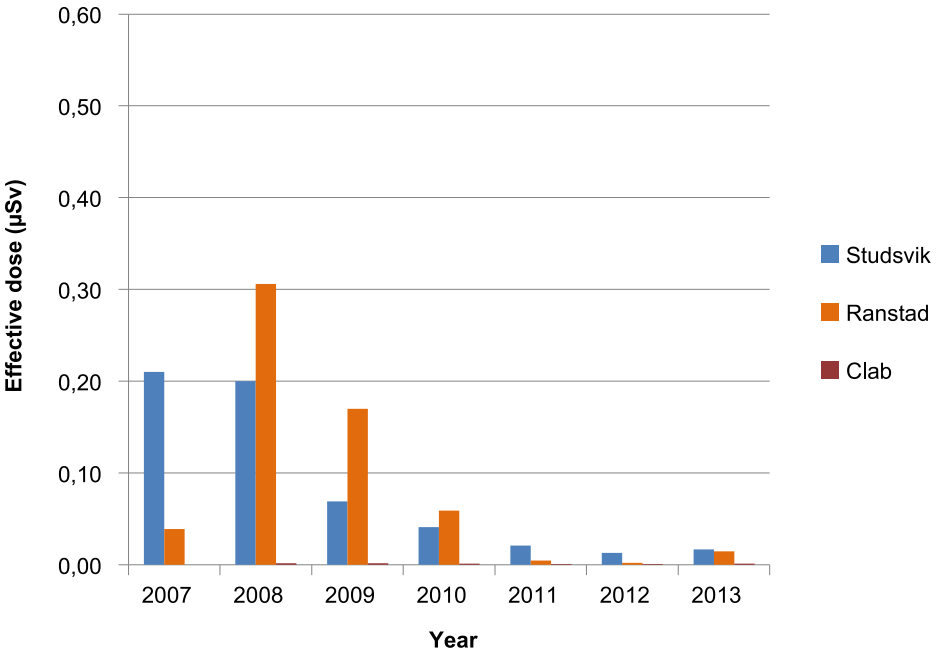

Figure F4: Effective dose to the representative person in the critical group (doses for Clab are too low to be visible from the diagram).

From the closed and partially dismantled Ågesta reactor (PHWR), small amounts of tritium are released through the drainage of the rock chamber where the shut down reactor is situated.

F.4.3 Regulatory control

See sections E.2.3.3 and F.3.3 for SSM's control and inspection work.

F.4.4 Conclusion

Sweden complies with the obligations of Article 24.

F.5 Article 25: EMERGENCY PREPAREDNESS

1. Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary, off-site emergency plans. Such emergency plans should be tested at an appropriate frequency.
2. Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

F.5.1 Regulatory requirements

The emergency plans for the three operating nuclear power plants and the industry facilities at Studsvik include installations for spent fuel and radioactive waste management at these facilities. SKB has an emergency plan for the Clab interim storage facility for spent nuclear fuel. There is no formal requirement for an emergency plan at SFR; however a crisis management and rescue organisation nevertheless exists. SSM's revised regulations for emergency preparedness and response impose new requirements that will lead to a new investigation of SFR and possible revisions of the formal requirements for an emergency plan. Westinghouse Sweden Electric AB operates the fuel fabrication facility in Västerås. This facility also has an emergency plan in accordance with SSM's regulations.

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

- the Civil Protection Act (SFS 2003:778) regarding protection against accidents with serious potential consequences for human health and the environment,
- the Civil Protection Ordinance (SFS 2003:789) regarding protection against accidents with serious potential consequences for human health and the environment,
- SSM regulations (SSMFS 2008:1) concerning safety in nuclear facilities, and
- SSM regulations (SSMFS 2008:15) concerning emergency preparedness at certain nuclear facilities.

The overarching objective of the Civil Protection Act (2003:778) is civil protection for the whole country – with consideration given to local conditions – for life, health, property and the environment against all types of incident, accident, emergency, crisis and disaster. The Act requires preventive measures and emergency preparedness to be arranged by the owner or operator of a facility conducting dangerous activities. The Act also defines the responsibilities for the individual, the local communities and the state in cases of serious accidents, including radiological accidents. The Act contains provisions on how community rescue services shall be organised and operated and also stipulates that a rescue commander with a specified competence, with far-reaching authority, is to be

engaged for all rescue operations. According to the Act, the county administrative board is responsible for rescue operations in cases where the public needs protection from a radioactive release from a nuclear installation or in cases where such release seems imminent.

The Civil Protection Ordinance (2003:779) contains general provisions concerning emergency planning and is more specific about reporting obligations, information to the public, and the responsibility of the county authority for planning and implementing public protective measures, content of the off-site emergency plan, competence requirements for rescue managers and inner emergency planning and monitoring zones around the major nuclear facilities. The county administrative board is obliged to draw up a radiological emergency response plan. The Swedish Civil Contingencies Agency is responsible at national level for coordination and supervision of preparedness for the rescue services response to radioactive releases. SSM decides on necessary measures for emergency planning at the nuclear installations and supervises the nuclear installations regarding these plans.

SSM's regulations SSMFS 2008:1 require the licensee in the event of an emergency to take prompt action in order to:

- classify the event according to the alarm criteria,
- alert the facility's emergency preparedness organisation,
- assess the risk and size of possible releases and time-related aspects,
- return the facility to a safe and stable state, and
- inform the responsible authorities.

The actions shall be documented in an emergency preparedness plan which is subject to safety review by the licensee and must be approved by SSM. The plan shall be kept up to date and validated through regular exercises. SSM is to be notified of changes to the plan. The licensee is required to assign the staff and provide the suitable facilities, technical systems, tools and protective equipment needed to perform the emergency preparedness tasks. The emergency planning should include all design basis accidents, as well as beyond design basis events including severe events, and combinations of events such as fire or sabotage in connection with a radiological accident.

SSM's regulations SSMFS 2008:15 on emergency planning and preparedness have a radiation protection perspective. They are mainly based on the IAEA Safety Standards GS-R-2: Preparedness and Response for a Nuclear or Radiological Emergency, and include requirements on:

- emergency planning including alarm criteria and alarming,
- emergency rooms/premises/facilities and assembly places,
- training and exercises,
- iodine prophylaxis,
- personal protective equipment,
- evacuation plan,
- contacts with SSM,
- radiation monitoring,
- emergency ventilation,
- collection of meteorological data,
- communication equipment.

Depending on the radiological hazard potential at the facility, the requirements regarding radiation monitoring, emergency ventilation and collection of meteorological data differ.

The SSM regulation 2008:15 is currently being revised.

F.5.2 National Structure

Appointed central or regional (county) authorities are responsible for managing nearly all accidents and crisis situations involving nuclear technology with potential off-site consequences. However, if a national crisis with the potential of affecting many citizens with (coupled) large and negative cross-sector or cross-regional economic, environmental or other detrimental societal effects occurs, this will require decisions and actions by the Government.

The county administrative board in the affected county (region) is responsible for planning and leading regional emergency preparedness work. It decides on measures to be taken to protect the public, issues warnings, provides information to the public and is responsible for decontamination following radioactive fallout/releases. The responsibility for directing rescue services also lies within the county administrative board in the affected county unless the Government decides otherwise.

The Crisis Management Coordination Secretariat within Sweden's central government offices is responsible for policy intelligence and situation reporting, crisis management, crisis communications and analysis, and is a central contact point at the Government Offices. The Secretariat gathers information, assesses a situation and recommends Government actions. The Prime Minister's Office, with the assistance of the Crisis Management Coordination Secretariat, must ensure that the necessary cooperation within the central government offices and with the relevant authorities is rapidly established. To facilitate cooperation between all authorities concerned, a crisis management advisory body has been formed within the central government offices. The State Secretary of the Prime Minister chairs the advisory body, which is composed of the National Police Commissioner, Supreme Commander and the Directors General of the state utility Svenska Kraftnät (Swedish National Grid), the Swedish Civil Contingencies Agency (MSB), the National Board of Health and Welfare and the Swedish Radiation Safety Authority. The advisory body also has as its members a county governor, representing the county administrative boards, and representatives from the Ministries of the authorities concerned. The State Secretary can also co-opt additional members.

MSB has the responsibility in preparedness work to support the coordination of preparedness measures taken by local, regional and national authorities. MSB also provides communication networks for the competent authorities during extraordinary events. MSB has the overall responsibility for the Swedish national digital communication system ('Rakel') that connects national emergency services and others in the fields of civil protection, public safety and security, emergency medical services and healthcare during emergency situations, and which is currently being implemented or already being used by municipalities, counties, national agencies and even commercial entities. MSB will also support the Swedish Government Offices by providing documentation and information in the event of serious crises or disasters and providing methods for crisis communication and the coordination of official information to the public.

The Swedish Radiation Safety Authority (SSM) has the responsibility to coordinate the necessary emergency preparedness and response measures for

preventing, identifying and detecting nuclear and radiological events that can damage human health or the environment. In the event of an accident involving nuclear technology in Sweden, or outside of Sweden with consequences for Sweden, SSM is the appointed National Competent Authority (NCA) and is responsible for providing advice and recommendations concerning protective measures regarding radiation protection, radiation measurements, cleanup and decontamination following a release of radioactive substances, for maintaining and leading a national organisation for measurement and expert support, and for providing advice and recommendations to the public and the public authorities assigned to deal with the impact of the event. SSM is also responsible for keeping the Government informed about the situation, developments, expected developments, available resources and measures taken as well as planned, and following a request by the Crisis Management Coordination Secretariat at the Prime Minister's Office, or by MSB, providing the information needed in order to paint an overall picture of the situation.

A number of authorities, organisations and laboratories will cooperate or operate as supporting functions to the national organisations mentioned above in the event of a nuclear or radiological emergency. Participating authorities that have cooperating roles for crisis management include, for example, the National Food Administration, which is responsible for taking decisions on action levels for the content of radioactivity in foodstuffs, and the Board of Agriculture, which is responsible for taking decisions on action levels regarding agricultural practices and products. Other authorities that have responsibilities during crises and that cooperate with SSM or receive advice and recommendations from SSM include the county administrative boards, MSB, the Swedish Board of Health and Welfare, Swedish Customs, the Swedish Meteorological and Hydrological Institute, Swedish National Police Board, Swedish Coast Guard and the local rescue leader, police and medical personnel.

The Swedish Meteorological and Hydrological Institute (SMHI) assists SSM by providing weather forecasts, weather data and some dispersion calculations in the event of a radiological or nuclear emergency.

In an international context, and in regards to the Community arrangement on early exchange of information, it is SSM's responsibility as both an EU and IAEA-designated Competent Authority, to promptly inform the European Commission, neighbouring countries that might be affected and the IAEA in accordance with the IAEA's Conventions on assistance and early warning and the European Commission's Convention on early warning. Furthermore, SSM is also responsible for continuously providing information on the measures that Sweden intends to take due to an emergency situation.

In the event of an emergency at a Swedish nuclear power plant or other nuclear facility, the licensee is responsible for immediately contacting the national alarm centre (SOS Alarm), which will in turn alert the authorities and organisations responsible for handling the situation, see Figure F5. In the event of a radiological or nuclear emergency abroad (with a possible request for assistance), the alarm will go to the Swedish Meteorological and Hydrological Institute (SMHI), which is the national contact point (National Warning Point, NWP).

The next step in the alarm process is contacting the officers on duty at SSM and MSB. SSM initiates the following step in the alarm process through automated contact with other officers on duty at designated central and regional authorities

and Government ministry offices. Central and regional authorities with roles and responsibilities in the acute phase of a nuclear accident or event are required by an ordinance and a Government decision to have an officer on duty (SFS 2006:942, Ordinance on Emergency Preparedness and Heightened State of Alert). Although Government ministry offices are not covered by this Ordinance, the ministries in charge of authorities having responsibilities relevant for crisis management maintain their own officer on duty.

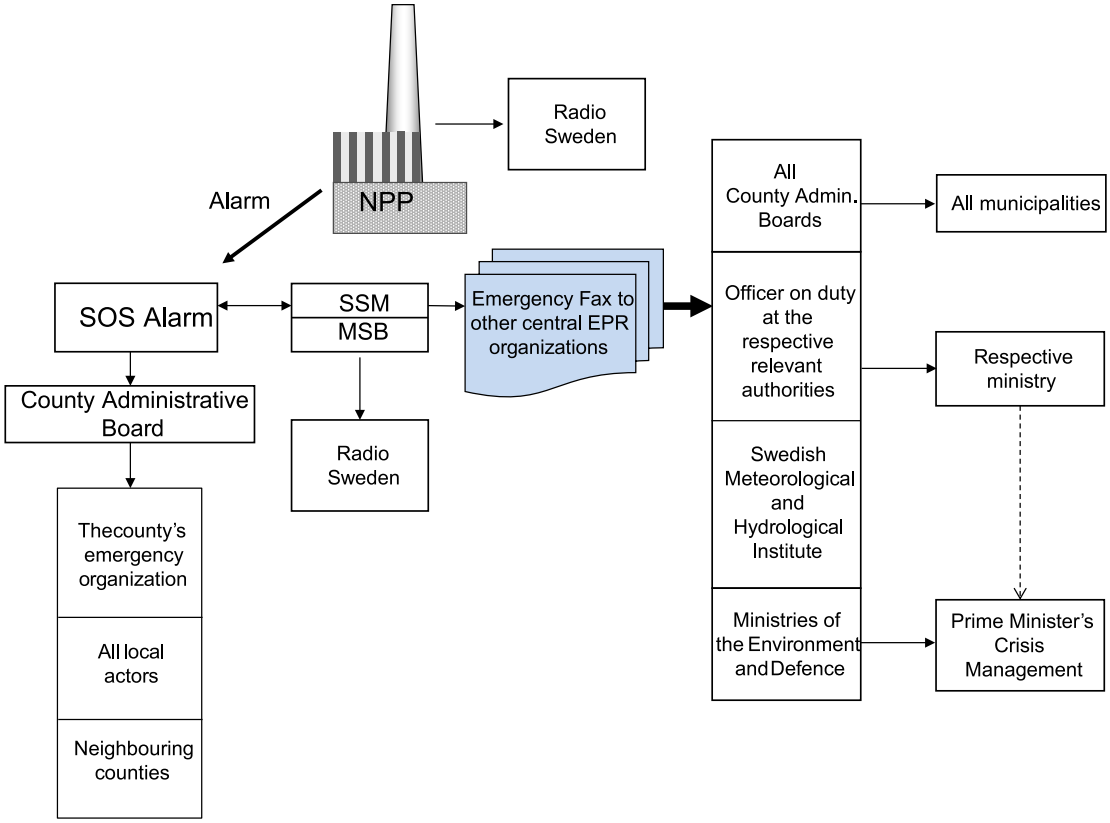

Figure F5: Current alarm sequence for an emergency event at a Swedish nuclear facility.

F.5.3 National Monitoring

Authorities, organisations and laboratories that comprise the national expert response organisation and, among other duties, participate in radiological monitoring and measurements following nuclear and radiological emergencies, are shown in Figure F6 with a summary of the contracted responsibilities covering fixed laboratory measurements, field and airborne mobile measurements and weather and plume dispersion prognoses. In addition to the tasks shown in Figure F6, the laboratories are also contracted for providing expert advice.

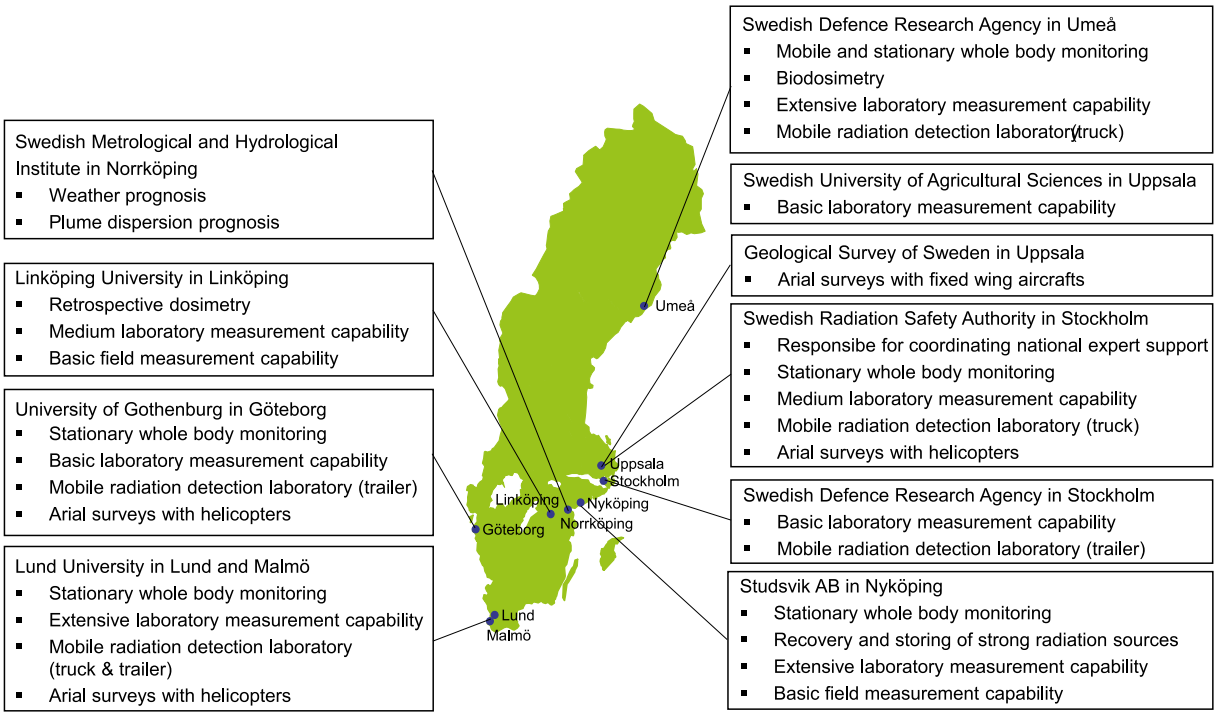

Figure F6: National expert response organisation for nuclear and radiological emergencies.

Also, a number of voluntary organisations, such as the Women's Voluntary Defence Service, the Women's Motor Transport Corps and the Women's Auxiliary Veterinary Corps, are prepared to provide assistance in the event of a radiological emergency. One area of assistance that these voluntary organisations are extensively trained and organised for is the rapid collection of agricultural field samples for transport to the national laboratory network for measurement. This will allow for early decision-making on agricultural countermeasures.

Sweden has acquired a new, modern gamma monitoring network which presently has 28 permanent stations spread around the country designed to provide warnings and rapid information on radiation levels. Each gamma station records the radiation level continually. If the integrated 24 hour radiation dose differs from the previous 24 hour period value by more than 10 %, the radiation protection officer on duty at SSM will be alerted. The alarm level can be changed according to prevailing conditions. There is also a fixed alarm level that is currently set at 300 nanosieverts per hour (300 nSv/h). Sweden also has six sensitive and permanent air filter stations which sample the air continuously and can reveal the type of plant from which radioactive releases originate. The system is sensitive enough to measure activity levels in the order of tens of microBq/m^3 (corresponding to approx. 100 atoms per cubic metre) and is therefore also used for environmental monitoring.

The gamma monitoring system is supplemented by radiation level data collected by the environmental and health care offices of local authorities at permanent measurement points every seventh month in the municipalities,

providing a background measurement base. The results of the measurements after deposition can be compared with these reference measurements which have been registered at 2–4 measurement points in each municipality. This data is collected from the municipalities by the county administrative board, which compiles and transmits the readings to a national database.

The Geological Survey of Sweden and the county police force are contracted for the use of aircraft and helicopters for airborne measurements of radiation. More detailed measurements are made to serve as a basis for decisions concerning, for example, declaring pasture land free of contamination for grazing.

F.5.4 Medical Emergency Preparedness

The county administrative board is responsible for medical disaster preparedness. Injured persons are cared and treated:

- through qualified medical care in the injury area, or
- in hospitals or at medical health centres.

At the major national hospitals, such as Karolinska Hospital in Stockholm, more advanced treatment and care can be arranged. Cooperation and sharing of resources also take place between European hospitals in the event of major accidents.

The Nuclear Medical Expert Group (N-MEG), appointed by the Swedish National Board of Health and Welfare, has an on-call operation and is available for giving advice, even in connection with minor incidents. Medical doctors from the medical fields of haematology, oncology, radiology and catastrophe medicine are represented in N-MEG. In the event of a major accident, relevant members of the group can be summoned to the national emergency centre located at SSM and are provided with information on radiation levels, meteorological conditions, etc. Using the information available, N-MEG performs a medical risk assessment and delivers the information and suggestions for measures primarily directed to the medical doctor in charge at the county administrative board's rescue work management group. N-MEG advises and informs the treating medical doctors and the medical care centres in the county.

In order to facilitate medical emergency preparedness in Sweden, the National Board of Health and Welfare has established the Centre for Radiation Medicine, located at Karolinska Institutet in Stockholm. The tasks of the Centre include contributing through healthcare information, education and advice and conducting research activities in areas related to medical effects of ionising radiation. Close collaboration has been established with SSM and various other national and international bodies.

F.5.5 Exercises

A number of emergency preparedness exercises of various scopes are conducted annually in Sweden. These vary in complexity from simple tests of alarm systems to full-scale exercises. Periodical tests of the alerting systems between the power plants and authorities are performed each year.

Every other year a "total" exercise is performed at one of the three nuclear power sites to check the planning and capability of the on-site and off-site organisations. The full-scale exercises are designed to enable evaluation of command at the regional level, national inter-agency cooperation and public information. The full-scale exercises are often also used for testing international communications.

The respective county authority where the plant is located has the responsibility for planning these exercises, often with the assistance of the national agency MSB, which is also responsible for the evaluation and follow-up analyses. SSM participates in planning and evaluation. Usually 15-30 organisations participate in these exercises, including the regulatory bodies and the Government.

A large exercise concentrating on accident management at the Westinghouse fuel factory in Västerås, Sweden was carried out 14–15 May 2013. The exercise was arranged by the county administrative board in Västmanland County and included both operational handling at the site and the area around the facility plus the strategic work of the county administrative board's crisis management staff. The exercise had a primary goal of testing the county administrative board's new emergency plan. Several actors participated in the exercise, including SSM and other central authorities, rescue workers, police, ambulance workers, emergency rooms at hospitals, radio and local community workers. An evaluation report has been produced and the county administrative board and other actors are working on mitigating identified problems.

In addition, a number of more limited on-site functional exercises are conducted at all the Swedish plants every year. Specific plans exist for these exercises. Exercised functions are for instance accident management, communication within the emergency preparedness organisation, environmental monitoring and sampling, assessment of core damage and source terms and assessment of total environmental consequences of a scenario. The rescue forces are exercised regularly, as well as first aid and emergency maintenance. SSM frequently participates in such exercises both as an observer, in its supervisory role, or to exercise the authorities' own emergency staff.

Other exercise scenarios have included physical protection events such as sabotage, armed intrusion and the taking of hostages in order to exercise coordination between the special police forces and other actors. In the spring of 2011 a large national exercise, SAMÖ-KKÖ, was performed based on a loss of cooling accident and partial core melt at the Oskarshamn NPP. It involved authorities and rescue organisations at central, regional and local level. The first phase, lasting for 48 hours, involved three shifts for the participating staff members, while the latter phase of 5-6 weeks was carried out by having the participating organisations solving problems, giving advice and suggesting countermeasures based on a radiological situation with widespread contamination resulting from the initial accident and its release of radioactive substances. During the latter phase of the national exercise, the March 11 nuclear accident at the TEPCO Fukushima Daiichi NPP in Japan activated and engaged the central Swedish national emergency organisation for several weeks to follow.

Sweden has a long tradition of participating in international emergency preparedness exercises. This allows for testing of aspects related to bilateral and international agreements on early notification and information exchange. Sweden regularly participates in the IAEA Convention Exercises (CONVEX), the OECD/ NEA International Nuclear Emergency Exercises (INEX) and yearly ECURIE exercises.

F.5.6 Measures taken to inform neighbouring States

Sweden has ratified the International Convention on Early Notification and the Convention on Assistance in the Case of a Nuclear Accident. An official national point of contact has been established that is available around the clock. Sweden has re-

gistered field and laboratory resources with the international assistance programme RANET, managed by the IAEA under the Convention on Assistance in the Case of a Nuclear Accident, and participates actively in developing the RANET system.

Sweden has bilateral agreements with Denmark, Norway, Finland, Germany, Ukraine and Russia regarding early notification and exchange of information in the event of an incident or accident at a nuclear power plant in Sweden or abroad. An agreement at regulatory body level has also been signed with Lithuania. Sweden uses the ECURIE information system for information exchange within the European Union and the ENAC/Emercon system for notification and information exchange between the IAEA member states.

The five Nordic countries of Denmark, Finland, Iceland, Norway and Sweden have compiled a Nordic manual describing communication and information routines between the countries for an extensive list of scenarios and which has been agreed upon by these five countries. Communication exercises are performed five times per year by these countries.

F.5.7 Nuclear accidents abroad

As demonstrated by the effects on Sweden from the Chernobyl accident of 1986, Sweden can be affected by radiological consequences from a nuclear accident abroad. Although the foreseeable consequences are such that the use of iodine tablets, sheltering or relocation of people due to fallout is not likely, the impact on agriculture, animal breeding, forestry, hunting, recreation and private household activities (fishing, picking mushrooms, game hunting, vegetable gardening, etc.) and on the environment can be substantial due to the uptake and concentration of radioactive substances in plants, animals and human food chains.

The responsibility of SSM and other authorities to distribute information is strengthened in this situation. The local county administrative boards that are affected still have the responsibility to inform and take any protective action in their region according to the above-mentioned legislation. During the Fukushima Daiichi NPP accident, where no direct impact on Sweden took place, SSM and other central authorities such as the National Board of Health and Welfare and MSB were responsible for providing information on the consequences of the event. The Swedish emergency organisation was activated and worked around the clock for three weeks analysing and evaluating the situation in order to give advice to the Swedish embassy and Swedish citizens in Japan.

Emergency preparedness and crisis management on a national level involve a number of national organisations and authorities as well as the Government. During the nuclear accident at the Fukushima Daiichi NPP, many national organisations were activated and the Swedish Radiation Safety Authority had its crisis organisation activated around the clock during the period of 11–31 March 2011 in the Emergency Response Centre located in the premises of the Authority.

Several other authorities and organisations were also affected by the situation in Japan, for example MSB, the National Board of Health and Welfare, Swedish Customs, the Swedish National Food Agency, the Ministry for Foreign Affairs, the Ministry of the Environment and the Swedish Defence Research Agency (FOI). The activities throughout this period led to a number of lessons learned regarding the performance of the national organisations. One example is the experience from the cooperation between SSM and the Swedish Defence Research Agency (FOI) during the accident. During the accident, FOI was contracted by SSM to assist

the emergency organisation and to perform analyses and supplementary radiation monitoring.

The nuclear accident at the Fukushima Daiichi NPP highlighted the importance of international cooperation and the capability of a country to coordinate assistance from international authorities and organisations during emergency situations. The Swedish Government appointed a Committee of Inquiry to examine the possibilities for Sweden to receive international support during emergency and crisis situations, including nuclear accidents. The experiences from the Fukushima Daiichi NPP accident were incorporated in the committee's inquiry. The results of the inquiry were delivered to the Government on 27 April 2012.

F.5.8 New developments in emergency preparedness

Experiences gained from SSM's supervision of emergency preparedness at certain nuclear facilities as well as experience gained from the Fukushima Daiichi NPP accident have led to a need for revision of the Swedish regulation SSMFS 2008:15, the Swedish Radiation Safety Authority's Regulations concerning Emergency Preparedness at Certain Nuclear Facilities. Specifically with regards to experiences gained from the Fukushima Daiichi NPP accident, the revised regulation proposed should impose clearer and more stringent demands regarding radiation protection of personnel and the communications infrastructure at a nuclear power plant. Furthermore, the revised regulation imposes specific demands regarding more stringent requirements for the licensee to be able to deal with the consequences and the evolution of those events that are used as the basis for emergency planning, for example with respect to initial response time, staffing, endurance, equipment and facilities. The emergency planning at each site shall be formulated to be able to deal with an emergency over a period of at least two weeks. There must also be logistical centres outside of the power plant grounds to act as a collection point for incoming equipment to the site. There are also specific demands on having a detailed plan for obtaining protective equipment in a drawn out or long-term event, on having a communications system that is not a public system, and a more stringent requirement on having an alternative command and control centre not located near the power plant and having alternative communications possibilities.

One of the 2012 IAEA IRRS review recommendations was that the Government should consider establishing a government level coordination body (committee, board, etc.) that would be responsible for the coordination of national efforts to cope with the longer term consequences of a severe emergency. A national radiation emergency response plan, which would describe the responsibilities and concepts of operation of this governmental body and the other response organisations, should also be drafted. Work on this recommendation is being conducted as a Government assignment during 2014 by the authorities MSB, SSM and the county administrative boards associated with nuclear power. These authorities shall prepare a draft national contingency plan for managing a nuclear accident. The results of the assignment will be presented to the government in January 2015.

As a result of this IRRS recommendation and the resulting and ongoing government investigation, the longer term effects of an accident and the needs regarding sanitation are also being characterized. Aspects related to the management of the resulting radioactive waste generated by an accident are also being examined in the investigation, including the legal aspects. The current system allows for deposition of the types of waste that could be generated by an

accident, though the amounts of possible waste and the place for the deposition of the possibly large amounts of waste need to be investigated further.

The IRRS team also suggested that SSM should consider developing online, real-time access to NPPs' operational and safety parameters. SSM is responsible for providing the county administrative boards with recommendations concerning the protection of people and the environment in the event of a nuclear accident. In an emergency situation, SSM requires credible and accurate information from the licensee in order to produce a well-founded recommendation. Information necessary for assessing source term and plant status is especially important. However, the plant parameters that would provide the basis for the thorough assessment of the situation and the predictable accident progression and radionuclide release are not available online in the Emergency Response Centre of SSM. Presently, such information is sent manually by the licensee to SSM via open fax lines using an existing paper template every half hour. In an emergency situation, the pressure on personnel and their stress can be overwhelming. Hence, a project enabling automatic electronic transmission of relevant site parameters via a secure transmission line from each nuclear reactor to the regulator was initiated in 2012. By 2017, when the project is finished, it will be possible to monitor and visualize plant status in real time, hopefully allowing SSM to better assess the whole scope of the situation during an ongoing accident. Part of the incoming parameters will be analysed by another program to give a better estimate of the source term.

Monitoring of gamma radiation in the vicinity of the nuclear facilities is not a part of the Swedish automatic gamma monitoring system operated by SSM. One of the suggestions of the IAEA IRRS review of the Swedish regulatory system was that SSM should consider extending the national gamma monitoring system for gamma monitoring stations to cover the areas near nuclear facilities. This work was already in progress, but not completed before the IRRS review. The procurement process is now ongoing and the present schedule is to have 20 measurement stations installed around each NPP by the end of 2014. The measurement stations will be located in a circle at an approximate 5 kilometre distance from the NPP, with one measurement station in each 15-degree sector facing land and slightly less densely in directions facing the North and Baltic Seas. There is an option in the procurement to install 10 additional measurement stations around each nuclear power plant at distances up to 50 kilometres from the NPP. If SSM decides to exercise this option, these additional measurement stations will be operational by the end of 2015.

The IRRS team also concluded the following Good Practice. SSM has established its state-of-the-art Emergency Response Centre, equipped with all the necessary tools and procedures as well as a national network of mobile and stationary laboratories to manage emergency response.

As a result of the accident in Japan and the subsequent activation of SSM's crisis organisation continuously over three weeks, several measures for improving the organisation have been identified. These have been compiled along with measures resulting from the evaluation of the SAMÖ/KKÖ exercise, and a number of them have been implemented in a first phase of prioritized improvements. Some examples of measures already taken are: clearer routines for incident documentation, improved routines and checklists for the different functions in the crisis organisation, supplementary training for staff and improvements in procedures for operational communication, shift planning, work schedules and

information management for the ordinary SSM organisation during the time that the crisis organisation is activated.

Another important measure is the updating and formalization of predefined criteria on countermeasures and the implementation of measurable operational intervention levels and routines for application of intervention levels. These measures are nearly completed, partly in coordination with the other Nordic countries through ongoing work on modernization of the Nordic Flag Book specifying protective measures in early and intermediate phases of a nuclear or radiological emergency.

The use of Rakel, the Swedish national digital radio system for public safety and security, has been further consolidated within the nuclear emergency and response community, including SSM. Work is currently in progress to enable the transmission of data from monitoring networks around the Swedish nuclear power plants over the Rakel network; the rationale for this work being the fact that the network is designed to withstand serious disturbances in societal infrastructure, including events such as disruption of the power supply and an overload of public communication networks. The Swedish Civil Contingencies Agency (MSB) has the overall responsibility for development, coordination and support of the network.

SSM has supported further developments in Sweden's dispersion modelling capabilities in cooperation with the Swedish Meteorological and Hydrological Institute (SMHI) and the Swedish Defence Research Agency (FOI). SSM now has routine access to a suite of modelling tools, including Eulerian, Lagrangian as well as Gaussian models, the latter one being implemented at SSM whereas the former are being implemented within the dedicated nuclear emergency computation cluster at SMHI. The resolution of the dispersion prognoses has been further enhanced by using higher resolution weather forecasts. The optimisation of the handling of the numerical weather prediction datasets at SMHI has enabled the possibility to perform dispersion calculations for any location in the northern hemisphere at short notice.

The county administrative boards in the counties that have nuclear power plants and the national authorities MSB and SSM have established an action plan including a variety of projects aimed at enhancing coordinated emergency planning and response for nuclear power plant accidents and incidents. These projects are ongoing and have different completion dates, the latest being in 2015. The projects aim at mitigating identified needs in the organisation of education and exercises, coordinating communication, coordinating national and regional measurement and analysis teams, further development and coordination of sanitation procedures, and creating a national information strategy.

As a follow-up to the TEPCO Fukushima Daiichi NPP nuclear accident, on May 25, 2011, SSM decided that the NPP licensees and SKB must redo the safety assessments for the NPPs and for the interim storage facility for spent nuclear fuel at Clab, located at Oskarshamn. As a result, improvements have been undertaken to improve the safety back-up system and improve the robustness of the water supply system for cooling at Clab and the electrical supply through new mobile electric generators.

F.5.9 Regulatory control

After the implementation of SSI's regulations concerning emergency preparedness at certain nuclear facilities in 2006, a series of inspections was carried out in 2007

and 2008 at all of the nuclear facilities that were covered by the regulations to ensure that implementation had been properly carried out. The conclusion was that the licensees complied with the requirements of the regulations. At all sites, however, aspects for further improvements were identified and SSM continued to follow up these findings during the period 2008–2013.

The merging in July of 2008 of SSI and SKI into a single authority, SSM, has provided the conditions for a clearer and more consistent picture of the requirements imposed by the combined regulations of the two former authorities. Supervision of emergency preparedness regulations is now concentrated to one national coordinating authority and the main responsibility for the supervision is organised within one section at that authority, which also provides a basis for a clearer supervisory role at the authority. The various relevant competences within the authority that are needed for its supervisory work are available and can be more effectively integrated in the supervision compared to earlier. This has led to more effective developments in the supervisory work as well as an increased number of inspections in a year.

One development that began during 2009 and is currently progressing to a new regulation concerns a review of the regulations (SSMFS 2008:15 and SSMFS 2008:1) originally issued by the former SSI and SKI, respectively. Here, the intention is to combine and harmonize all aspects of regulating emergency preparedness at the licensees and to utilise earlier experiences from the implementation of the regulations to revise the regulations with the expected result of clearer and stronger requirements imposed on nuclear installations. The new SSM regulation replacing SSMFS 2008:15 is currently scheduled to be officially approved and implemented on January 1, 2015.

F.5.10 Conclusion

Sweden complies with the obligations of Article 25.

F.6 Article 26: DECOMMISSIONING

Each Contracting Party shall take the appropriate steps to ensure the safety of decommissioning of a nuclear facility. Such steps shall ensure that:
(i) qualified staff and adequate financial resources are available;
(ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;
(iii) the provisions of Article 25 with respect to emergency preparedness are applied; and
(iv) records of information important to decommissioning are kept.

Since the last review meeting, the following changes have been made in SSM's regulations of importance to decommissioning:

- Previously there were two sets of regulations relevant to decommissioning, one developed pursuant to the Act on Nuclear Activities (SFS 1984:3), and the other pursuant to the Radiation Protection Act (SFS 1988:220). These have now been combined and updated within the regulations and general advice concerning safety in nuclear facilities, SSMFS 2008:1 (see especially Chapter 9 and Appendix 5).
- New regulations and general advice have been developed by SSM concerning clearance of materials, rooms, buildings and land in practices involving ionising radiation: SSMFS 2011:2.

F.6.1 Regulatory requirements

According to the Act on Nuclear Activities, a licence holder for nuclear activities is responsible for ensuring that all measures are taken in order to:

- maintain safety, taking into account the nature of the operation and under what circumstances it is conducted,
- ensure safe management and disposal of nuclear waste generated from the operation and nuclear material derived from the operation that is not reused, and
- ensure safe decommissioning of facilities in which the operation has been discontinued until such date that all operations at the facilities have ceased and all radioactive waste has been disposed of.

It follows from the third item that a licence holder is not exempted from responsibilities according to the act until decommissioning has taken place and all radioactive waste has been disposed of.

According to the Radiation Protection Act, a licence holder for nuclear activities shall take all measures that are necessary for radiation protection of people and the environment.

According to the Act on Nuclear Activities, no specific licence is required for decommissioning of nuclear facilities. However, according to the Environmental Code, a licence is needed for decommissioning and dismantling of nuclear reactors. In

addition to the specific requirements, as described in section E.2.2.4, the applicant also has to show compliance with a number of principles, e.g. the knowledge principle, the precautionary and BAT principles, and the after-treatment liability principle.

Chapter 9 of the general regulations SSMFS 2008:1 sets out a number of specific requirements relating to decommissioning, including:

- A preliminary plan for the future decommissioning of the facility is to be compiled before construction of a facility;
- Safety and radiation protection at the time of decommissioning shall be taken into account during the construction of a facility and before changes are made in an existing facility;
- The preliminary plan shall be supplemented and kept up to date for the duration of the facility's operation and shall be reported to SSM every ten years;
- During the operation of a facility, observations and events that have significance for planning and execution of decommissioning shall be documented on an ongoing basis;
- When a decision has been made on final shutdown of a facility within a certain period of time, an integrated analysis and assessment of how safety is to be maintained during the time remaining until the facility's closure shall be conducted without delay. An analysis and assessment of organisational changes during the closure period and personnel requirements during decommissioning shall also be conducted. The analyses, assessments and measures emanating from these shall be documented and reported to SSM;
- Within a year of final shutdown, the decommissioning plan shall be updated and supplemented, and shall include a description of which parts of the facility and which equipment will be required during decommissioning as well as which preparatory actions will need to be undertaken before dismantling and demolition can commence;
- Before dismantling of the facility may be initiated, the updated decommissioning plan shall be further developed and the revised plan reported to SSM. Also, the facility's safety analysis report shall be supplemented in accordance with the revised plan. A safety review of the revised safety analysis report shall be performed by the licence holder and the report shall be reviewed and approved by SSM before dismantling and demolition commence;
- Where the decommissioning plan is divided up into a series of smaller work sequences or partial projects, a review of the planned measures during each sequence shall be communicated to SSM before these activities commence. The review shall also include protective measures that are planned in addition to those specified in the facility's safety analysis report. Rationales shall be provided for the choice of decontamination, dismantling and demolition methods. An analysis and assessment shall be included in the review of risks and consequences that have significance for safety, physical protection and radiation protection and if these are addressed in the facility's safety analysis report. After the work sequence or partial project is completed, a review of the execution of the work and measures shall be performed and submitted to SSM;
- Considerations, measures undertaken and results of measurements shall be documented on an ongoing basis during decommissioning; and
- A decommissioning report on the actual execution of the decommissioning

work, with descriptions of the experience gained and the final state of the facility, shall be compiled and submitted to SSM after the dismantling and demolition work is completed.

The information to be contained in the decommissioning plan is specified in SSMFS 2008:1 (Appendix 5). This includes requirements relating to documentation of the facility, prerequisites for planning, and the decommissioning activity itself.

The general obligations in the regulations SSMFS 2008:1 and several other regulations are applicable to decommissioning and dismantling activities regarding:

- the availability of qualified staff and financial resources (as accounted for in section F.2);
- the application of provisions with respect to operational radiation protection, discharges and unplanned and uncontrolled releases (as accounted for in section F.4); and
- the application of provisions with respect to emergency preparedness (as accounted for in section F.5).

The regulations and general advice concerning clearance of materials, rooms, buildings and land in practices involving ionising radiation, issued as SSMFS 2011:2, are to, in a satisfactory way from the perspective of radiation protection, enable the rational management and use of materials, rooms, buildings and land that may have been contaminated by radioactive substances in practices involving ionising radiation. In these regulations, 'clearance' means that the Radiation Protection Act and the Act on Nuclear Activities shall no longer be applied to materials, rooms, buildings or land. Among other requirements, the regulations specify that, during decommissioning, actions shall be taken in order to achieve clearance of rooms, buildings or land.

The regulations contained in SSMFS 2008:38 require archiving of documentation at nuclear facilities. The licence holder shall archive documentation related to radiation protection aspects of a practice. If the practice ceases the archives shall be transferred to the National Archives of Sweden or Regional Archives. Detailed requirements on keeping a register for the radioactive waste at nuclear facilities are given in SSMFS 2008:1. The register must for instance contain information on the origin of the waste and the amount and nuclide specific content of the waste. Moreover, the decommissioning report mentioned above should include a description of what has been done with all the wastes arising from dismantling and demolition, including conventional and operational wastes.

F6.2 Measures taken by the licence holders

The nuclear power companies are responsible for decommissioning of the nuclear power plants as well as related financing. Decommissioning of the plants is described in plans where the degree of detail will increase as the time for decommissioning approaches.

SKB is tasked with assisting the nuclear power companies in fulfilling their obligations. The responsibility includes performing the necessary research and development activities required to fulfil the obligation to adopt all measures needed to safely decommission facilities when the nuclear activity will no longer be conducted.

As a part of this assignment, SKB participates in the planning and execution of the decommissioning of the NPPs and primarily coordinates the use of general methods and procedures for the decommissioning work, including calculation of waste volumes, radionuclide inventory and costs.

Plant-specific decommissioning studies have been performed in order to estimate waste quantities, timetables and costs. The studies are based on the actual decommissioning planning and serve as a basis for determining capacities in SKB's final repository system and fees to be allocated to the Nuclear Waste Fund.

SKB and the nuclear power companies participate in various national and international fora and collaborations of decommissioning that may be of value for activities in Sweden.

Management of decommissioning waste is coordinated through SKB. The future disposal of decommissioning waste is also a task of SKB.

F.6.2.1 Commercial power plants

There are three commercial nuclear power plants in operation today: the Ringhals, Forsmark and Oskarshamn sites, having a total of 10 reactor units. The closure of the first reactors with an estimated lifespan of 50 years is expected to commence in the 2020s after which the installations will be decommissioned and/or dismantled. In 2013 the three licence holders submitted updated preliminary decommissioning plans to the Swedish Radiation Safety Authority according to the SSM regulation SSMFS 2008:1.

A decommissioning plan for the two Barsebäck units was previously submitted to and approved by the regulatory authorities. All nuclear fuel has been removed and transported to Clab for interim storage. System decontamination has been carried out for both reactors and dismantling is planned to start when the extension of the SFR facility is finalized and ready to receive the decommissioning waste. Decommissioning of Barsebäck 1 and Barsebäck 2 is planned to be done as a joint project, and the requirements are planned to be clarified before the project is started. The final goal of decommissioning is that the Barsebäck NPP is cleared in accordance with regulatory requirements.

F.6.2.2 Ågesta PHWR

The pressurized heavy water reactor in Ågesta was permanently shut down in 1974. Two steam generators were dismantled and waste treated in Studsvik in the early 1990s as part of an NEA research project. Currently, preparations are being made for radiological characterisation and planning of future decommissioning, intended to begin in 2020. A licence under the Environmental Code for continued care and maintenance until 2020 was issued by the local Land and Environmental Court in November 2008. In December 2009, the company AB SVAFO applied to take over the licence according to the Act on Nuclear Activities from the current licensee, Vattenfall AB. The application is still under review by the Swedish Radiation Safety Authority, which shall give its recommendation to the Ministry of the Environment. Aspects for the Authority to consider in the review of the application include financial provisions, adequacy of the management system and organisational capabilities.

F.6.2.3 Research facilities

Studsvik material test reactors

The two material test reactors in Studsvik (one tank type and one mobile pool type) were permanently shut down in 2005. Preparations for dismantling of the reactors are ongoing. Decontamination of two test loops was performed in 2008. Dismantling of the reactors has been delayed partly due to a request from the European Commission on complementary information according to Euratom Treaty Article 37. After revision, the Article 37 report was approved in 2013 by the Commission. The licence according to the Act on Nuclear Activities has been transferred from the operator Studsvik Nuclear AB to the decommissioning and waste management company AB SVAFO.

According to the new time schedule, dismantling activities will continue until 2018 to achieve an end state with the facility prepared for free release. A safety report and waste management plan for dismantling of the reactors have been delivered to the authorities. Dismantling of the reactors is planned to commence in late 2014 or in the beginning of 2015, after review and approval by SSM.

Installations in Studsvik

There are a number of facilities at the Studsvik site that are in the process of being decommissioned and/or dismantled. Plans for the decommissioning and dismantling of these facilities have, before actual decommissioning activities started, been prepared by the license holders and submitted to SSM for evaluation and approval, according to requirements in the general regulations.

Decommissioning of minor nuclear installations in Studsvik is being performed by the licensee AB SVAFO. Two old underground silos for liquid intermediate level waste have now been decontaminated and partially dismantled. AB SVAFO has applied to the Swedish Radiation Safety Authority for clearance of the remaining underground structures and the foundation of the earlier building.

F.6.2.4 Installations in Ranstad

The uranium mining and milling facilities in Ranstad were constructed and operated in the 1960s. In total, about 200 tonnes of uranium were produced. The uranium open-cast mine and the mill tailings deposits were restored and covered in the 1990s. Currently, decommissioning of the remaining facility is proceeding. Part of the facility was until 2009 used for extraction of uranium from waste originating from nuclear fuel fabrication. This licence expired in December 2009 and the installations are planned to be decommissioned as a part of the decommissioning project for the leaching and extraction plant. An extensive radiological survey has been performed and detailed plans are being developed for the dismantling of remaining systems, demolition of buildings and restoration of the site. The former mineral processing plant was dismantled and demolished following approval by the Swedish Radiation Safety Authority. The remaining ground was inspected by the local municipality authorities according to the Planning and Building Act in October 2013. Waste from the dismantling with slight contamination of uranium shales has been transported to a landfill for hazardous waste, after clearance by SSM. The decommissioning activities for the remaining nuclear installations in Ranstad, mainly the leaching plant, are planned to continue until 2016.

F.6.2.5 SKB facilities

The decommissioning plan for the SFR facility has been updated and will be included in the application for the extension of the facility. Decommissioning of SFR will begin when the main activity ceases, not to be resumed, and will continue until the above-ground facility has been cleared and there are no radiological reasons to prevent the establishment of another industrial activity on the site. The extent of demolition beyond this depends mainly on how the site will be used in the future.

SKB has conducted a decommissioning study of the combined Clab and encapsulation facility (Clink), based on the actual planning, focusing on waste volumes, radioactivity content and costs.

A decommissioning plan has been written for the spent fuel repository and was included in the application under the Act (1984:3) on Nuclear Activities for disposal of spent fuel and under the Environmental Code for the KBS-3 system.

F.6.3 Regulatory control

See sections E.2.3.3 and F.3.3 for details of the SSM system of control and inspections.

The updated preliminary decommissioning plans submitted last year by the licence holders of the operating nuclear power plants, Ringhals, Forsmark and Oskarshamn, were recently audited by SSM. The audit was based on the requirements stated in SSM's regulations SSMFS 2008:1. Several inadequacies were identified and the plans were not approved by the Authority. Previously injunctions were communicated to the licence holders. A consultation with SSM, initiated by the licence holders, will be held in 2014 and the licence holders will submit a time schedule regarding the updating of the inadequacies at the end of 2014.

F.6.4 Conclusion

Sweden complies with the obligations of Article 26.

Section G – SAFETY OF SPENT FUEL MANAGEMENT

The general safety requirements presented in section G are essentially the same as those for radioactive waste management under section H. Parts that are common to both section G and section H have been presented in section G only, and thus been referred to in section H. To the extent the requirements differ between the safety of spent fuel management and safety of radioactive waste management, this is stated in the respective section. The management of spent nuclear fuel including development of a geological disposal facility is described in this section, whereas the programme for radioactive waste repositories is described in section H.

G.1 Article 4: GENERAL SAFETY REQUIREMENTS

Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards. In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;
(ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;
(iii) take into account interdependencies among the different steps in spent fuel management;
(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;
(v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;
(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;
(vi) aim to avoid imposing undue burdens on future generations.

G.1.1 Regulatory requirements

G.1.1.1 The general obligations of licence holders

As accounted for in section E.2.2.1, the Act on Nuclear Activities requires that the holder of a licence for the operation of a nuclear power reactor shall – in cooperation with the other holders of a licence for the operation of nuclear power reactors – establish and carry out an R&D programme for the safe handling and disposal of spent fuel and nuclear waste. Every third year the programme shall be submitted to the Government, or an authority assigned by the Government, for evaluation.

Also, as accounted for in section E.2.2.6, the Financing Act requires the licensees to submit, every three years, estimates of all future costs for management and disposal of spent nuclear fuel and nuclear waste, and decommissioning. The licensee of a nuclear power reactor shall base costs estimates on 40 years of operation with a minimum remaining operating time of 6 years. The licensee of nuclear facilities other than nuclear power reactors shall base cost estimates and the build-up of adequate financial resources on the expected remaining period of operation.

G.1.1.2 Basic provisions and licence obligations

Basic safety provisions are stipulated in the Act on Nuclear Activities (1984:3). The requirements are further clarified in the general safety regulations SSMFS 2008:1. In the regulations it is stated that, in order to ensure adequate protection at all stages of spent fuel management and radioactive waste management, the licensee shall:

1. establish documented guidelines for how safety shall be maintained at the facility as well as ensure that the personnel performing duties important for safety are well acquainted with the guidelines;
2. ensure that the activities carried out at the facility are controlled and developed with the support of a quality system which covers those activities of importance for safety;
3. ensure that decisions on safety-related issues are preceded by adequate investigation and consultation so that the issues are comprehensively examined;
4. ensure that adequate personnel is available with the necessary competence and suitability in all respects needed for those tasks which are of importance for safety as well as ensure that this is documented;
5. ensure that responsibilities and authority are defined and documented with respect to personnel carrying out work which is important for safety;
6. ensure that the personnel is provided with the necessary conditions to work in a safe manner;
7. ensure that experience from the facility's own activities and from similar activities is continuously utilised and communicated to the personnel concerned; and
8. ensure that safety, through these and other measures, is maintained and continuously developed.

In the Radiation Protection Act (1988:220) it is stipulated that radioactive waste shall be handled and disposed of in a manner that is satisfactory from a radiation protection point of view.

There are regulations on the protection of human health and the environment in connection with the management, including disposal, of spent nuclear fuel and nuclear waste (SSMFS 2008:37) with a focus on application of radiation protection principles for the long term. There are also requirements concerning the long-term safety of a disposal facility in the regulations SSMFS 2008:21. These latter two regulations impose requirements on the design and long-term safety assessments of disposal facilities.

G.1.1.3 Criticality and removal of residual heat

The general safety regulations (SSMFS 2008:1) state that radiological accidents

shall be prevented by the design, construction, operation, monitoring and maintenance of a facility. Requirements on prevention of unintended criticality are included in a section on defence in depth, and heat generation and removal of residual heat are to be considered in the operating limits and conditions of any nuclear facility.

G.1.1.4 Interdependencies among the different steps in spent fuel management

The fact that the licence holders are responsible for the handling and disposal of the spent nuclear fuel they generate provides an incentive to consider all steps from generation to disposal. Detailed requirements are stipulated in SSM's general regulations (SSMFS 2008:1 and SSMFS 2008:3).

- Measures for the safe on-site handling and storage of spent fuel shall be analysed and verified, and included in the safety report of the facility. The safety report shall also include measures that need to be taken on-site to prepare for the safe subsequent transport, storage or disposal of spent fuel (SSMFS 2008:1).
- An inventory of all spent fuel on-site must be kept updated at all times (SSMFS 2008:3).
- Plans shall be drawn up providing a general description of management, including disposal, of spent nuclear fuel likely to be generated while operating the facility. The plans shall be reported to the authorities for approval before commissioning (SSMFS 2008:1) of nuclear reactor facilities.
- As regards spent nuclear fuel deviating from that specified in the plans as stipulated above, all necessary measures for management of the non-conforming material shall be explained and documented in a separate plan. The separate plan shall be reported to the authorities before handling of the spent fuel (SSMFS 2008:1).
- Acceptance criteria shall be derived stating the properties of the spent nuclear fuel that can be received for storage, disposal or any other management. Acceptance criteria shall, to the extent that is feasible and possible, be formulated while taking into account safety and radiation protection throughout all steps of spent fuel management. Procedures must be in place for management of material that does not meet the acceptance criteria, e.g. by returning it to the consignor or by taking measures to rectify identified deviations (SSMFS 2008:1).

G.1.1.5 Protection of individuals, society and the environment

General radiation protection provisions are described in section F.4.1. Radiation protection of the public and the environment in connection with spent fuel management is specifically addressed in SSM's regulations SSMFS 2008:37, SSMFS 2008:21 and SSMFS 2008:1; see also E.2.2.3. In summary it is required that:

- a disposal facility for spent nuclear fuel shall be designed so that the annual risk of harmful effects after closure does not exceed 10^{-6} for a representative individual in the group exposed to the greatest risk;
- disposal of spent nuclear fuel and nuclear waste shall be implemented so that biodiversity and the sustainable use of biological resources are protected; and
- human health and the environment shall be protected during the operation of a nuclear facility as well as in the future.

G.1.1.6 Account of biological, chemical and other hazards

General information

Biological, chemical and other hazards will be addressed in the licensing process of an activity. Any such risks that might be associated with the activity should be reported in the Environmental Impact Assessment (EIA). The EIA should also include a description of the measures envisaged to prevent, reduce or remedy adverse effects. During operation the operator is required to continuously take protection measures and precautions to prevent or hinder the activity from causing damage or harm to human health or the environment from chemical, biological and other hazards as well as from a radiological point of view.

Supervision of work to deal with chemical and biological hazards is primarily exercised by county administrative boards.

Chemical and biological hazards in the context of spent fuel management

Non-radiological environmental risks during construction and operation of the facilities have been studied and results are presented by SKB in the Environmental Impact Statement (EIS) submitted to the regulators as part of the licence application for the disposal of spent nuclear fuel. The study includes identifying and evaluating environmental risks and hazards that might occur during construction and operation of the facilities. Detailed results from the study are presented in a separate report[12] that is used as a reference in the EIS. Moreover, SKB keeps and manages a register of all chemical products stored and used for maintenance and operation of its existing facilities. The register is continuously updated. Chemical products introduced to the facilities must be registered. SKB intends to use the same system for registration of chemicals for its new facilities.

Post-closure safety for a repository is specifically addressed in SSMFS 2008:21. In fact, although the chemical content of the waste could justify applying regulations concerning hazardous waste, its radioactive content is the decisive factor for the management and disposal of this waste. Hence, the Act on Nuclear Activities and the Radiation Protection Act overrule other specific regulations governing hazardous waste (for example, the Waste Ordinance, SFS 2011:927) that would have been applicable if the waste were not radioactive. However, a post-closure chemotoxic assessment[13] for the disposal of spent nuclear fuel was performed by SKB. The study focuses on the chemical toxicity of the radioactive waste (apart from its radiotoxicity) after closure of the facility. The results of the study are briefly presented in the EIS submitted to the regulators together with the licence application for the disposal of spent nuclear fuel. The study is used as a reference in the EIS. The study comprises a detailed inventory of the chemical elements contained in a sealed copper canister (including the spent nuclear fuel). After a screening of the potentially most problematic chemical elements contained in the canisters, a conservative scenario for release in the biosphere has been used to estimate concentration of chemicals in groundwater and surface water. The concentration estimates were then compared to existing norms and recommendations for water quality and water consumption. The conclusion of the study is that the chemical toxicity of the elements in a copper canister is estimated to be low.

[12] *SKB Report 2009, P-09-78, can be downloaded at www.skb.se.*

[13] *SKB Report 2010, P-10-13, can be downloaded at www.skb.se.*

The topic was discussed within SKB's RD&D programme as well as during the national consultations carried out according to the Environmental Code.

G.1.1.7 Striving to avoid impacts on future generations

As described in section E.2.1.1, the practices for the management of spent fuel and radioactive waste are governed by principles adopted by the Swedish Parliament. The first governing principle is that costs for the treatment and disposal of spent fuel and radioactive waste from nuclear activities shall be covered by fees that licensees are required to pay. The second principle is that the licensees are to safely dispose of spent nuclear fuel and radioactive waste from nuclear activities. These principles imply that a burden on future generations should be avoided, especially with regard to the fundamental aspects of safety and costs. The principles also imply that action should be taken without undue delay, i.e. the generation that has benefited from the nuclear power generation should also deal with the management and disposal of spent nuclear fuel and radioactive waste. SSM's regulations SSMFS 2008:23 state that human health and the environment shall be protected from harmful effects of ionising radiation during the operation of a nuclear facility as well as in the future. Furthermore, the regulations SSMFS 2008:37 contain general requirements stipulating that human health and the environment shall be protected from detrimental effects of ionising radiation during all stages of the management of spent nuclear fuel or nuclear waste.

G.1.2 Measures taken by the licence holders

G.1.2.1 The general obligations of licence holders

Cost calculations
Cost calculations have since the beginning of the 1980s been submitted on a regular basis by the licence holders of nuclear power reactors in cooperation. From the beginning they were submitted on an annual basis, but are currently submitted every third year. SKB submitted in January 2014 the most recent cost calculations under the Act (2006:647) on Financial Measures for the Management of Residual Products from Nuclear Activities.

RD&D Programme 2013
The nuclear industry, through its co-owned company SKB, has performed research on final disposal of radioactive waste since the mid-1970s. The formal requirement for an RD&D programme to be submitted for regulatory evaluation was established in 1984 when the Act on Nuclear Activities was promulgated. During the 1990s the research was intensified with extensive feasibility studies (in eight municipalities). In 2001-2002, two municipalities approved further investigations. The initial site investigations were concluded by the end of 2007 and the results reported in preliminary site descriptions. In June 2009 the board of SKB decided to choose Forsmark as the site for the repository for spent nuclear fuel. In March 2011, SKB's applications for a permit to build a repository system were submitted to the Swedish Radiation Safety Authority (SSM) and the Land and Environmental Court in Stockholm. Since 1986, SKB has produced ten RD&D programmes with KBS-3 as the main alternative for the disposal of spent fuel. In September 2013, SKB submitted the tenth RD&D programme to the regulator, SSM, for review and a public consultation.

In RD&D programme 2013, SKB presents its plans for research, development and demonstration during the period 2014–2019. The programme consists of five parts:

Part I	SKB's activities and plan of action
Part II	Low and intermediate level waste
Part III	Spent nuclear fuel
Part IV	Research for assessment of long-term safety
Part V	Social science research

G1.2.2 Basic provisions and licence obligations

Measures taken by the licensees regarding general safety requirements are discussed in sections G.3.2, G.4.2, G.5.2 and G.6.2.

Central storage facility for spent nuclear fuel (Clab)
SKB is the licensee for Clab, the interim storage facility for spent nuclear fuel located at the OKG site. From the start of operation in 1985 until 2006, the operations were contracted to OKG. In January 2007 SKB took over the operation of Clab in order to operate it within SKB's own organisation.

Prior to the introduction of the general regulations, the requirement on a periodic safety review (PSR) was a condition in the NPP licences. In the general regulations SSMFS 2008:1, the requirement on periodic safety reviews is now mandatory for all nuclear facilities.

The fuel storage pools in Clab were expected to be completely filled in early 2004. Therefore, in 1996, SKB initiated a project to increase the storage capacity from 5,000 to 8,000 tonnes of fuel by excavating a new rock cavern to provide additional storage pools.

The construction of the new storage pools (Clab 2) was completed during 2004. SKB submitted an application for a licence to take the pools in operation in December 2004, supported by an updated safety report. The regulatory authority requested amendments to the updated safety report and SKB submitted a new revision of the report in 2005. Clab 2 was taken in operation on 1 January 2008 after an affirmative regulatory decision based on e.g. regulatory approval of a renewed safety analysis report (SAR) for the extended facility.

Spent fuel from the research reactor R1 in Studsvik
During 2007 the intact parts of the R1 fuel, see section D1.1, were separated from corroded parts, in the form of powder and lumps, and transported to the United Kingdom, see also section K.5.2. The intact parts were reprocessed in 2008. The remaining waste from reprocessing was sent back to Sweden in 2009.
About half (42 out of 82 kg) of corroded parts of the R1 fuel has been sent to the Clab facility pending final disposal. The remaining part consists of coarse pieces of corroded metallic uranium fuel that will likely require reconditioning prior to transport to Clab.

G.1.3 Regulatory control

G.1.3.1 The general obligations of licence holders

Nuclear waste fees and guarantees
In December 2011, the Government decided to raise the nuclear waste fee to be paid by the nuclear power plant owners to the Nuclear Waste Fund from an average of SEK 0.01 per kWh of produced nuclear electricity (ca EUR 0.9 per MWh) to an average of SEK 0.022 (ca EUR 2.0 per MWh) for the period 2012-2014.

In January 2014, SKB submitted new cost estimates to SSM on the nuclear reactor owner's liabilities for the management and disposal of spent nuclear fuel and nuclear waste. By 7 October 2014, SSM is to submit review results to the Government together with a new proposal for fees and guarantees to be decided upon for the period 2015–2017.

Evaluation of the RD&D Programme
SKB submitted in September 2013 the nuclear reactor owner's tenth programme for research, development and demonstration since 1986, the RD&D programme 2013, to SSM for review and broad consultation with national stakeholders. In March 2014, SSM submitted the results of its evaluation and a statement to the Government with a recommendation to approve SKB's RD&D programme.

The overall conclusion from the regulatory review as regards spent fuel management is that the programme was deemed appropriate for its purpose. The evaluation of the programme was however restrained so as to not anticipate eventual conclusions of the ongoing review of the licence applications for an encapsulation plant and a spent fuel disposal facility.

The main conclusions drawn by SSM from the regulatory review with regard to the safety of spent nuclear fuel management were:

- The programme is a step forward in developing and implementing solutions to the disposal of spent nuclear fuel in a manner which complies with the requirements on safety and radiation protection. Still, there are continued long-term research and development needs in the management and disposal of spent nuclear fuel.
- Although the programme gives a good overview and understanding of the planned research and development needed for implementing a spent fuel disposal system, SSM requested that future programmes be more clearly structured and also clarify the justification of the RD&D programme based on needs and requirements. The programme report should describe in more detail the activities, in terms of research, technology and model development, etc., that have been implemented during the period since the last programme, the outcomes from activities carried out and future activities planned to be implemented.

Based on SSM's review statement, the Government is expected to approve of the general direction of the continued programme. In connection with the decision, the Government may also issue conditions concerning the content of the future RD&D programme.

G.1.4 Conclusion

Sweden complies with the obligations of Article 4.

G.2 Article 5: EXISTING FACILITIES

> Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.

By the time the Joint Convention entered into force for Sweden, the situation as regards safety of spent fuel management facilities was satisfactory. The elements of the Joint Convention have long been implemented as requirements in the legal and regulatory framework and implemented in the management of spent fuel. Dedicated inspection and review activities carried out in the early 2000s confirmed that the licensees' activities were in conformance with the legal and regulatory requirements. This conclusion has been reaffirmed during subsequent inspection and review activities.

Sweden complies with the obligations of Article 5.

G.3 Article 6: SITING OF PROPOSED FACILITIES

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:
   (i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;
   (ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;
   (iii) to make information on the safety of such a facility available to members of the public;
   (iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.
2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

G.3.1 Regulatory Requirements

G.3.1.1 Assessment of safety and environmental impact

According to the Environmental Code and Act on Nuclear Activities, a licence is required to construct, possess and operate any nuclear facility (the licensing procedure is described in section E.2.3.1). An application must demonstrate that the requirements are fulfilled under these enactments as well as the Radiation Protection Act. It must also be made clear that the more detailed requirements contained in SSM's regulations can be met. The most important regulations in this context are:

- Regulations concerning safety in nuclear facilities (SSMFS 2008:1).
- Regulations concerning safety in connection with the disposal of nuclear materials and nuclear waste (SSMFS 2008:21).
- Regulations concerning the protection of human health and the environment in connection with the final management of spent nuclear fuel and nuclear waste (SSMFS 2008:37).

Key inputs for the application are the Environmental Impact Assessment (EIA) and the preliminary safety report.

The procedures for carrying out the EIA, as well as its content, are specified in the Environmental Code (see section E.2.2.4). The EIA must contain the following elements:

- A description of the activity or measure with details of its location, design and scope.
- A description of the measures being planned with a view to avoiding, mitigating or remedying adverse effects.

- The information needed to establish and assess the main impacts on human health, the environment and management of land, water and other resources that the activity or measure is likely to have.
- A description of possible alternative sites and alternative designs, together with a statement of the reasons why a specific alternative was chosen and a description of the consequences if the activity or measure is not implemented.
- A non-technical summary of the information.

Requirements on the content of the safety report are given in the regulations concerning safety in nuclear facilities, and include (for example):

- A description of how the site and its surroundings, from the standpoint of safety, can affect the facility.
- A description of the design basis, including the requirements that have determined the design and construction of the facility. Descriptions of facilities for the handling of spent fuel or nuclear waste shall contain requirements that are determined by the description of safety in the particular disposal facility after closure.
- A description of measures taken to ensure adequate protection of workers, the public and the environment from radiation, as required by the Radiation Protection Act and regulations promulgated according to that Act.

However, site selection has, prior to the submission of the application, been the subject of consultations between the applicant (SKB), SSM, the municipalities concerned and NGOs. Such consultations have taken place in connection with the EIA (see section G.3.1.2) and the review of the R&D programme (see sections E.2.2.1 and G.1.3.1).

G.3.1.2 Public information and involvement

The legal framework for the licensing of nuclear activities gives provisions on transparency, openness and public participation. There are several procedures that serve the purpose of involving the public in siting of new spent nuclear fuel and nuclear waste facilities. As mentioned above, an EIA must be performed for any new nuclear facility. Swedish legislation emphasizes the role of the public and other stakeholders in the EIA. The EIA must for instance contain a plan for the formal process of consultation with stakeholders. The developer must initiate early consultations with those parties that might be affected by a new facility.

Parties that must be consulted include:

- municipalities that may host the facility,
- regulatory authorities, primarily SSM and county administrative boards,
- national environmental organisations,
- local interest groups, and
- affected individuals, e.g. land owners or those living close to a proposed location.

The county administrative boards have an important function besides participating in the consultations. They are requested to assist the developer in identifying stakeholders and to facilitate consultations and the exchange of information.

Furthermore, the regulatory authority (SSM) is tasked to perform a formal consultation of the nuclear power plants' joint RD&D programme that is produced and submitted to SSM by SKB. These consultations provide a broad range of the parties concerned with information regarding new facilities as well as a possibility to state opinions in the pre-licensing process.

According to the Act (2006:647) and Ordinance (2008:715) on Financing of Management of Residual Products from Nuclear Activities, the municipalities that might host a spent nuclear fuel or nuclear waste facility, including a disposal facility, are reimbursed for information activities aimed at their citizens. Municipalities have been reimbursed for their information activities since the mid-1990s. Currently, the municipalities of Östhammar and Oskarshamn are receiving reimbursement. In 2004 the Parliament approved a new regulation in the Financing Act, which made it possible for non-profit, non-governmental organisations as well to apply for financing. These organisations are entitled to financial support from the Nuclear Waste Fund until 12 months after the EIA has been announced by the Land and Environmental Court, for details, see section E.2.2.5. Decisions concerning reimbursement to municipalities and non-profit organisations are made by SSM. So far two municipalities and six non-governmental organisations have received funding to facilitate their participation in the siting and licensing process for a spent nuclear fuel repository.

Preceding a Government's licensing decision on an encapsulation plant and a spent nuclear fuel repository, the host municipality concerned has a right to veto and must formally declare its support or rejection of the decision. In practice, the formal consultations, the financial support to host municipalities and certain environmental organisations, and the municipal right to veto have so far been very beneficial to the overall quality and public acceptance of the licensing process for a spent fuel repository. SKB's strategy to involve the local communities on a voluntary basis in the siting process for a spent fuel repository has been another important factor, see section G.3.2.

The Swedish approach to building trust in the high level waste management system as well as the integrity of the regulator was credited as a Good Practice in the 2011 IAEA IRRS review.

G.3.1.3 Consulting contracting parties

Sweden (as well as the EU, Canada and USA) has ratified the Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention). The purpose of the convention is to seek cooperation to prevent transboundary environmental effects and the requirement to inform neighbours and the public about planned activities that might cause environmental effects. The provisions of the Convention are mainly implemented in the Swedish Environmental Code by means of the requirements imposed on Environmental Impact Assessments, EIA. The Environmental Code specifies that if another country is likely to be affected, the responsible authority as designated by the Government shall inform the competent authority in that country about the planned activity. The country concerned and the citizens who may be affected should be given the opportunity to take part in the consultation procedure. The Government has designated the Swedish Radiation Safety Authority to be responsible for this task.

Consultations as an outcome of the Espoo Convention have recently taken place between Sweden, Finland and Poland due to these countries' plans for new

nuclear power plants and due to Sweden's plans for a repository for spent nuclear fuel.

As an EU Member State, Sweden is also required to apply Article 37 of the Euratom Treaty. This Article obliges each Member State to provide the Commission with general data relating to any plan for the disposal of radioactive waste in whatever form as will make it possible to determine whether the implementation of such a plan is liable to result in the radioactive contamination of the water, soil or airspace of another Member State. Sweden has previously notified the Commission of the decommissioning of the R2 research reactors at Studsvik. Currently there is an ongoing notification of the planned facility for the European Spallation Source in Sweden. The repository for spent nuclear fuel, which is currently under review by SSM, will be notified in a timely manner.

G.3.2 Measures taken by the licence holders

G.3.2.1 General information

All spent fuel and radioactive waste facilities that are planned, including repositories, will be sited, constructed and operated by SKB. The supporting RD&D programme is also run by SKB. The following activities have recently been carried out or are in progress:

- The RD&D programme has been reported on every third year since 1986. The most recent RD&D report was submitted in 2013.
- Consultations and an EIA for the planned encapsulation facility (Clink) and the repository for spent nuclear fuel began formally in 2002, but in practice started in the mid-1990s. The consultations were concluded in May 2010.
- Consultations and an EIA for the planned extension of the final repository for short-lived radioactive waste, SFR, began in 2010 and was concluded during spring 2014.

G.3.2.2 Site selection for the repositories

The Environmental Code states that "in the case of an activity or measure for whose purposes a land or water area is used, a site shall be chosen that is suitable in order to achieve the purpose with a minimum of damage and detriment to human health and the environment". The legislation also requires a presentation of an alternative to the selected site. The prospects for achieving the purpose of disposal are dependent on the properties of the bedrock. The fundamental requirement on the site that is chosen is therefore that the rock at the site satisfies the safety requirements. In order for the site to be available and the project to be feasible, there must also be acceptance in the municipality concerned and among nearby residents. These basic requirements have guided SKB's siting work.

The spent fuel repository

The siting procedure has been performed in a stepwise manner. In order to find the most suitable site for the spent fuel repository, SKB conducted general siting studies (general and regional compilations and analyses), feasibility studies (comprehensive compilations and analyses of siting prospects at the municipal level) and site investigations (comprehensive investigations of bedrock and biosphere at selected sites), see Figure G1.

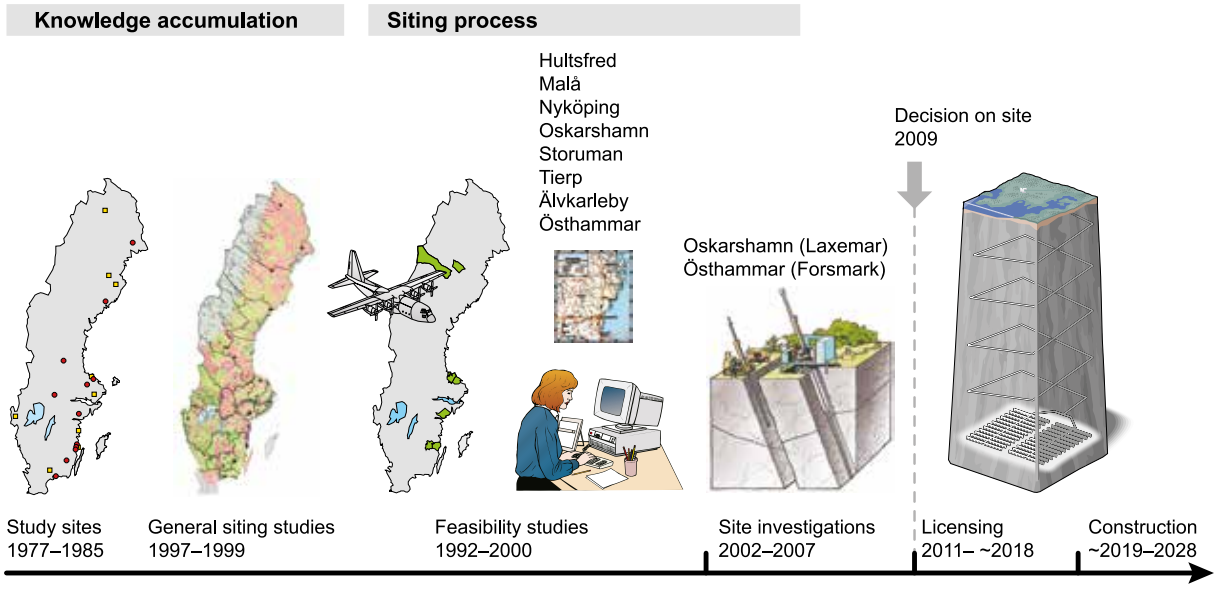

Figure G1: The stepwise procedure for the siting of a spent fuel repository.

In various RD&D programme decisions, the Government has made declarations on the need for background material for site selection. In a decision taken in May 1995, the Government stated that future applications for a licence to build a repository should contain material that shows that site-specific feasibility studies have been conducted at between five and ten sites in the country and that site investigations have been conducted at no less than two sites. SKB conducted feasibility studies in eight municipalities between 1993 and 2000: Storuman, Malå, Östhammar, Nyköping, Oskarshamn, Tierp, Älvkarleby and Hultsfred. At the end of 2000, SKB presented its conclusions from the feasibility studies of the different sites and a programme for continued site investigations. Both geological and industrial prospects as well as environmental and societal aspects were evaluated. Eight siting alternatives were judged to be sufficiently promising to warrant further studies. In its decision in November 2001 on the complementary report to the RD&D programme 1998[14], the Government stated that "the Government judges that the company should use the KBS-3 method as a planning premise for the upcoming site investigations."

SKB made a selection and wanted to conduct site investigations in three areas, situated in the municipalities of Östhammar, Oskarshamn and Tierp. However, Tierp Municipality withdrew in 2002 and was thereby no longer a candidate site. In Östhammar and Oskarshamn, clear majorities of each municipal council spoke in favour of the proposed site investigations. In 2002 SKB commenced site investigations in the Forsmark area in Östhammar Municipality and in an area in Oskarshamn Municipality that included the Simpevarp Peninsula and the Laxemar area. The investigations could gradually be concentrated to a smaller area in Forsmark and to the Laxemar area west of Simpevarp.

[14] *The Government's decision on the RD&D programme 1998 included requirements on SKB to submit supplementary material. See SKB's website, www.skb.se, SKB Technical Report TR 01-03.*

In the site investigations, SKB collected data on the properties of the bedrock, the soil layers and the ecosystems that are needed to analyse the prospects for a safe repository. Obtaining the necessary knowledge of the properties of the rock has required drilling boreholes to and below repository depth on a large scale. In June 2009, with the support of these investigations, SKB made its selection of a site for a future repository: Forsmark in Östhammar Municipality.

The site was selected by SKB after a systematic evaluation and comparison of the two final alternatives, Forsmark and Laxemar. The prospects for post-closure safety were paramount in the evaluations. SKB argues that the advantages of Forsmark in relation to Laxemar is that there are few water conducting fractures in the rock at repository depth, which means that the groundwater flow through the repository is limited. This, according to SKB, provides great advantages for the long-term performance of the copper canister and the bentonite clay. The rock at repository level in Forsmark has few fractures and is relatively dry and also offers advantages for construction and operation. In the EIS, SKB claims that the activity in the repository will not give rise to unacceptable damage and detriment for human health and the environment.

Consultations and environmental impact statement

Early consultations have been carried out for both the encapsulation plant and the repository for spent nuclear fuel, in both Oskarshamn and Forsmark.

Extended consultations began during 2003 with the county administrative board, other government agencies, the municipalities, the citizens and the organisations that are likely to be affected. The consultations were coordinated for the encapsulation plant and repository for spent nuclear fuel. The consultations related to location, scope, design and environmental impact of the activity or measure and the content and structure of the environmental impact statement.

Initially, the extended consultations mainly dealt with the scope of the EIA. Preliminary scoping reports were prepared as a basis for discussion. Viewpoints and proposals that emerged during the consultations were taken into account in the planning of the continued EIA process.

In the subsequent investigation phase, results from investigations and studies as well as proposals for facility design were presented at the consultation meetings, and the participants were given opportunities to state their views.

In May 2010, the consultations were concluded. All questions and viewpoints stated in the conclusions, together with SKB's answers and comments, are reported in full in the compiled documentation from the conclusions.

A preliminary version of the environmental impact statement (EIS) for the whole disposal system, including the spent fuel repository in Forsmark, has been presented within the framework of the EIA consultations. In addition to the formal consultations, extensive information activities have been aimed at municipalities, organisations and the public.

G.3.3 Regulatory control

As described in section G.3.2, SKB's programme for the siting of a spent nuclear fuel repository has included a national screening of potentially suitable areas, feasibility studies in eight municipalities and surface-based site investigations at two sites. SSM and its predecessors (the Swedish Nuclear Power Inspectorate, SKI, and the Swedish Radiation Protection Authority, SSI) have over three decades

been reviewing and analysing SKB's siting programme with the aim of preparing for the licensing review and providing guidance to SKB on the format and content of the planned licence application. The main instruments for regulatory control of SKB's siting programme have been:

- review of SKB's recurrent programme for research, development and demonstration (RD&D programmes),
- consultation meetings with SKB on their site investigations at two candidate sites,
- participation in EIA consultation meetings led by SKB in accordance with the requirements in the Environmental Code, and
- independent review and analyses of SKB's site investigation data and site descriptive models.

SSM and its predecessors have reviewed SKB's RD&D programme every third year since 1986. In each review, SSM consults formally with stakeholders. SKB's RD&D programme is circulated for comments to a large number of organisations, including universities, government agencies, NGOs and the municipalities involved in SKB's siting programme. When the review is completed the RD&D programme, together with SSM's recommendations, are sent to the Government for its decision on SKB's continued programme.

In connection with the review of the 1998 RD&D programme, the Government requested that SKB should prepare an overall assessment of results from the national screening of potentially suitable areas, feasibility studies and other relevant information as a basis for a selection of sites for site investigations. Based on this overall assessment, SKB proposed that Forsmark, Simpevarp and Tierp should be considered candidate sites and be the subjects of a comprehensive site investigation programme. The Tierp option was eventually dropped as a result of a decision by the municipality. As a basis for the decision to start site investigations, site investigation programmes and the preliminary safety assessment SR-97 were also produced. SKI and SSI reviewed in particular SKB's justification of the site selection as well as the preliminary safety assessment, SR-97. Based on these review activities, the Government subsequently concluded in a decision in 2001 that SKB could start the investigations at the candidate sites using the KBS-3 method as a planning requisite for the site investigation. The Government added that this should not discount the formal method selection at the time of repository licensing.

The Government also concluded that SKB should conduct consultation meetings with SKI and SSI during the full duration of the site investigation programme. Both authorities contributed to these consultation meetings, which were held between 2001 and 2010, by asking questions and providing comments related to SKB's site investigations and site selection. The authorities also set up two independent review groups with international experts focusing on geosphere and biosphere issues for detailed evaluation of SKB's site investigation methods as well as their interpretation of site-specific information. A series of reports[15] is publicly available covering all external regulatory reviews and analyses of SKB's site investigation programme.

[15] *Available at www.ssm.se.*

In 2009 SKB announced that the upcoming construction application would be based on the Forsmark site. SSM did not review SKB's site selection at that time since this remains an essential and necessary part of the present licensing review.

SSM is currently reviewing SKB's selection of the Forsmark site in Sweden for the proposed repository for spent nuclear fuel as part of the ongoing licensing review. The objective of this review is to determine whether the site can be considered to inhibit, limit and delay radionuclide releases from both engineered and geological barriers as far as is reasonably achievable. This requirement originates from SSM's regulatory requirements (Section 4 of SSMFS 2008:37), but also from the Environmental Code, which has a similar requirement. The evaluation is based on a weighted consideration of site suitability from different perspectives related to (for instance) hydrogeology, geochemistry, rock mechanics, etc.

As far as concerns hydrogeology, SSM has requested complementary information from SKB about SKB's analysis of site suitability from the perspective of hydrogeological path lengths and travel times from the repository to the biosphere. In particular, a more explicit comparison with the previously ruled out inland Hultsfred site (west of Oskarshamn Municipality) with potentially long pathways has been requested.

G.3.4 Conclusion

Sweden complies with the obligations of Article 6.

G.4 Article 7: DESIGN AND CONSTRUCTION OF FACILITIES

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

(i) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;

(iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

G.4.1 Regulatory requirements

The requirements for limiting the possible radiological impact on individuals, society and the environment, including those from discharges or uncontrolled releases, are founded upon the basic provisions in the Act on Nuclear Activities, the Radiation Protection Act and the Environmental Code.

G.4.1.1 Measures to limit radiological impact

The regulations concerning safety in nuclear facilities (SSMFS 2008:1) apply to the construction, operation and decommissioning of all types of nuclear installations, including facilities for the treatment, storage and disposal of spent fuel and radioactive waste. Furthermore, there are additional requirements in regulations concerning safety in connection with the disposal of nuclear material and nuclear waste (SSMFS 2008:21) and regulations concerning the protection of human health and the environment in connection with the final management of spent nuclear fuel and nuclear waste (SSMFS 2008:37). The latter regulations contain basic requirements regarding the protection of human health, expressed as a risk target, and general criteria regarding the protection of the environment.

A basic requirement is that nuclear accidents shall be prevented through a basic facility-specific design that shall incorporate multiple barriers as well as a facility-specific defence-in-depth system. The defence-in-depth shall be achieved by ensuring that:

- the design, construction, operation, monitoring and maintenance of a facility is such that abnormal events, incidents and accidents are prevented;
- multiple devices and measures exist to protect the integrity of the barriers and, if the integrity should be breached, to mitigate the ensuing consequences; and
- any release of radioactive substances, which still may occur as a result of extreme events, incidents and accidents, is prevented or, if this is not possible, controlled and mitigated through devices and prepared measures.

In addition to the above requirements, optimisation must be performed and Best Available Technique (BAT) shall be taken into consideration in the final management of spent nuclear fuel and radioactive waste. The objective is to ensure that all reasonable measures to improve the protective capability of a disposal facility are considered in all stages of the development, operation and decommissioning of a final repository system. When judging the reasonableness of different measures both economical and societal factors should be taken into account.

G.4.1.2 Conceptual plans and provisions for decommissioning

The Act on Nuclear Activities states that the holder of a licence for nuclear activities is responsible for ensuring that all necessary measures are taken to ensure the safe handling and disposal of nuclear waste, or nuclear material that is not reused, as well as the safe decommissioning of facilities.

The Act on Nuclear Activities also states that the licence holders of nuclear power reactors shall make conceptual plans for decommissioning of facilities and ensure that comprehensive research and development activities are conducted in order to fulfil the requirements concerning decommissioning and waste management.

The regulations concerning safety in nuclear installations (SSMFS 2008:1) contain requirements on decommissioning plans for nuclear facilities and state that decommissioning shall be taken into account when designing a facility, see also section E.2.2.2.

G.4.1.3 Technology supported by experience

The general regulations concerning safety in nuclear installations (SSMFS 2008:1) specify requirements regarding design and construction. It is stated that the design of the facility, with adaptation to the specific conditions of each facility, shall:

- be able to withstand component and system failures;
- have reliability and operational stability;
- be able to withstand such events or conditions which can affect the safety function of the barriers or defence-in-depth; and
- have maintainability, controllability and testability of inherent parts as long as these parts are used for their intended purposes.

Additional requirements related to design and constructions are:

- The design principles and design solutions shall be tested under conditions corresponding to those that can occur during the intended application in a facility. If this is not possible or reasonable, they must have been subjected to the necessary testing or evaluation related to safety.
- The design solutions shall be adapted to the personnel's ability to manage the facility, in a safe manner, under normal conditions as well as during abnormal events, incidents and accidents that might occur.
- Building components, devices, components and systems shall be designed, manufactured, installed, controlled and tested in accordance with requirements that are adapted for their importance for safety.

G.4.2 Measures taken by the licence holders

G.4.2.1 Suitable measures to limit radiological impact

The safety philosophy applied in the design of all Swedish nuclear facilities is based on the principles of defence-in-depth and of multiple barriers to prevent the release of radioactive material to the environment. They are all designed to fulfil the intention of the requirements in the General Design Criteria. The foundation of the safety principle on the defence in depth is emphasised and made clearer through the implementation of that principle in the general regulations SSMFS 2008:1.

G.4.2.2 Conceptual plans and provisions for decommissioning

According to the Act on Nuclear Activities, a licence holder for nuclear activities is responsible for ensuring that all measures are taken in order to ensure the safe decommissioning of facilities. The general regulations SSMFS 2008:1 sets out a number of specific requirements relating to decommissioning, including a preliminary plan for the future decommissioning to be compiled before construction of a facility, see section F.6.1.

In July 2012, SSM received an application from the power company Vattenfall for the replacement of one or two reactors at the existing sites in operation. SSM has been commissioned by the Swedish Government to prepare new regulations in order to develop well adapted and updated requirements for new nuclear power reactors. New requirements on the construction and operation of reactors will have to be met in order to minimize contamination during operations and to facilitate the eventual decommissioning.

Decommissioning studies have been developed by SKB as part of the basis for the cost calculations, see section E.2.2.5. In the tri-annual RD&D programmes (see section G1.2.1), SKB also reports on the research and development measures needed for safe decommissioning and dismantling of the nuclear power plants. In the most recent RD&D programme review statement from March 2014, SSM recommended that the Government approve SKB's programme reporting, with the condition that SKB and the nuclear power reactor operators consult with the Authority on the development of a more detailed planning on decommissioning of the reactors.

The ten reactors in operation at three nuclear power plant sites in Sweden are scheduled to be decommissioned during the period 2025-2055. The ongoing planning and preparatory work on decommissioning at the Barsebäck, Ågesta, Studsvik and Ranstad facilities is described in section F.6.2.

G.4.2.3 Technology supported by experience

General information

The principle of proven technology is broadly accepted and implemented in the design and construction procedures for nuclear facilities in Sweden. As is evident from the applications submitted for Clink and the spent fuel repository, a reference design has been adopted for the repository barriers for long-term safety that fulfils the design premises for the KBS-3 system. At the same time, a feasible approach to production and a quality control programme has been presented.

The applications for Clink and the spent fuel repository have been brought forward with the experience from a number of preliminary safety analyses,

starting with the KBS-3 report in 1983 (the first complete safety analysis of the KBS-3 method), followed by SKB-91 (focusing on the technical barriers), SR-97 (focusing on the geological barrier), and lastly SR-Can in 2006 (a dress rehearsal for the development of the SR-Site safety analysis that supported SKB's licence application). These iterative safety analyses have had multiple roles including guiding the technical development of the disposal method and site selection, identifying areas requiring further research, and determining whether a repository for radioactive waste complies with the regulatory requirements on long-term safety. As mentioned in G.3.3, G.4.3 and G5.3, the open and transparent stepwise process with reviews by the authorities, international experts as well as interested stakeholders of both the preliminary safety analyses and SKB's RD&D reports, has proved to be an effective way to raise the level of knowledge regarding management and disposal of spent nuclear fuel, and has also given feedback to SKB's technology development and design work.

The Canister Laboratory, Äspö Hard Rock Laboratory and Bentonite Laboratory have all been used for several years in developing technologies for encapsulation and disposal of spent fuel. In addition, certain tests have, and will also in the future, in cooperation with Posiva, be conducted at Posiva's hard rock facility, Onkalo, situated in Olkiluoto, Finland. There are also underground laboratories and laboratories for metallurgical research available in Europe and other parts of the world. In addition, there are industrial facilities in many countries with access to the knowledge and resources needed to carry out development work for SKB. The experience from experiments and tests in these laboratories is and will be used when the encapsulation plant and the repository for spent nuclear fuel are designed and constructed.

The structure presented by SKB in previous RD&D programmes, where technology development is divided into a number of production lines, has been retained and refined in RD&D programme 2013. This means that the development work for the barriers for long-term safety is being pursued in production lines for fuel, canister, buffer, backfill, closure and underground openings. The production lines for buffer, backfill and closure share a number of common issues, so the development work for these production lines is integrated. Furthermore, technical systems are being developed for e.g. logistics and machines that are unique to the final repository.

Continued technology development is being pursued to proceed from schematic solutions to solutions that are tailored to an industrialized process with stipulated requirements on quality, cost and time. A large part of the remaining development work consists of building up a production system with quality control.

Design premises

The design premises comprise requirements which the KBS-3 facilities with their barriers must satisfy in order to ensure safety both during operation and after closure. The design premises specify e.g. what mechanical loads the barriers must be able to withstand, limitations concerning the composition and properties of the barrier materials, acceptable deviations in the dimensions of the barriers, and acceptance criteria for the various underground openings.

An initial set of design premises and other requirements is specified in the applications for construction of the spent fuel repository and the encapsulation part of Clink. However, it is not possible to specify all detailed design premises for

a given product or process from the start. Requirements, technology development and safety assessment must instead be formulated as the work proceeds. A revision of the design premises that were presented in the applications is currently being performed.

The basic principles for evaluating design premises pertaining to several barriers in the spent fuel repository are:
- The design premises shall altogether lead to compliance with requirements related to the safety of the entire spent fuel repository.
- The design premises shall be practically achievable and verifiable for all the barriers concerned.
- Design premises that entail simple, robust and effective solutions are preferred.

These principles are used to weigh together requirements for fuel, canister, buffer, backfill, closure and underground openings. The revised design premises serve as a basis for the preliminary safety analysis reports which SKB compiles prior to the start of construction of the spent fuel repository and the encapsulation part of Clink. They will be presented to SSM when the PSAR is submitted.

Further revision of the design premises will be performed in response to the conditions issued during the licensing process and in conjunction with updating of the safety analysis reports. More detailed specification or re-appraisal of the relative importance of requirements between different systems may also need to be done during detailed design or prior to implementation.

Quality control and inspection

"Quality control and inspection" refers to the measures that need to be taken to provide assurance that the requirements imposed on the facilities during operation and after closure of the spent fuel repository are satisfied. The goal is that the results obtained should conform to acceptable values for properties that contribute to safety and radiation protection.

Planned production as well as quality control and inspections in the production of the barriers for long-term safety have been described in general terms in the production line reports. As development of production and testing methods progresses, the work on quality control and inspection will also progress. Systems for quality control and inspections will be established and implemented to quality assure the production of the barriers.

A number of important activities in this process are to:
- establish principles for safety and quality classification,
- establish what is to be quality controlled and quality inspected, when quality control and inspections are to be performed and by whom in terms of first, second and third parties,
- establish and qualify processes, methods, equipment and personnel for manufacturing and installation, testing and inspection,
- establish the procedures that are to be applied in production to ensure that the KBS-3 repository satisfies quality requirements,
- deliver the control model for technical development.

Technology development for the encapsulation plant and spent fuel repository is carried out using the SKB delivery control model. According to the delivery control model, technology development is subdivided into four phases: concept phase, design phase, implementation phase and operation and maintenance phase. For each phase there is a specification of what must have been achieved and what is needed as a basis for a decision to proceed to the next phase.

Plans
In the short term, the goal of technology development is to ensure that the technology needed to begin construction of the spent fuel repository and the encapsulation part of Clink is available prior to the start of construction. In the case of the spent fuel repository, this mainly refers to investigation methods and technology for construction of the repository accesses. This material is also needed for the document on handling of matters relating to nuclear safety prior to the start of trial operation, i.e. during construction of accesses, the central area and the first deposition area, Suus (abbreviation for "safety during construction of the final repository"), which SKB must prepare prior to the start of construction. Technology development is also needed for the systems that must be in place in the repository area in order for SKB to be able to present and obtain approval of the PSAR prior to the start of construction.

After the submission of the PSAR there are several other key milestones during the design and construction of the planned facilities where key input is needed from the technology development. This includes:

- At the start of detailed design of the encapsulation part of Clink, the component technical systems must have essentially passed the detailed design phase. At the start of detailed design of the canister factory, technology and methods for production of canisters must be fully developed and work on an industrial scale.
- Prior to the start of construction of the encapsulation part of Clink and the canister factory, those systems that have undergone detailed design shall have been procured and plans for qualification shall have been established and incorporated in the plans for construction.
- Before detailed design of the spent fuel repository's accesses can start, the Observational Method for underground construction must be implemented and a detailed characterisation programme for ramp and shafts must be available.
- Below the level of the top seal on the spent fuel repository, the design premises stipulate requirements on the permeability of the installations intended to seal the repository at depth. This in turn imposes other requirements on rock work beneath the top seal. This means that it must be verified that excavation methods, inspection programmes and methods for rock support and grouting satisfy the requirements that apply to the level under the top seal.
- Detailed design of the production of buffer and backfill shall be completed as a basis for detailed design of the production building.
- Installation methods and methods for testing and inspection of buffer and backfill must have been designed in detail and verified prior to detailed design of the deposition area.

Technical systems that are needed in Clink must have been purchased, fabricated, installed, tested and qualified prior to commissioning tests of the KBS-3 system.

Before commissioning tests can be done, methods and sub-processes for excavation of the spent fuel repository must have been devised and qualified. The deposition system must be put into operation before commissioning tests can be undertaken, which means that technical systems for handling and transport of canisters, buffer and backfill must have been fabricated, installed and tested. The systems will undergo integration tests to ensure that equipment and technical systems work together as intended before the commissioning tests. Qualifications of processes with appurtenant equipment, personnel and suppliers must have been completed and documented. A system for quality control and inspection of canister manufacturing, production of buffer and backfill components, handling and installation of canister, buffer and backfill and the rock construction process must be implemented.

Before a licence can be obtained for trial operation of Clink and the spent fuel repository, a renewed SAR must be submitted. Before an operating licence can be obtained, a supplemented SAR must be prepared and submitted to SSM. Results and experience from the implementation phase must be presented in this updated SAR, including the results of the commissioning tests in each facility. This means that the production reports will be updated using results from full-scale tests, qualifications and commissioning tests.

G.4.3 Regulatory control

The Swedish Radiation Safety Authority (SSM) and its predecessors (the Swedish Nuclear Power Inspectorate, SKI, and the Swedish Radiation Protection Authority, SSI) have over the past 30 years reviewed SKB's development of the KBS-3 disposal method for spent nuclear fuel, mainly in the context of:

- regulatory review of the recurrent Research, Development and Demonstration programmes (RD&D programmes),
- reviews and peer reviews of SKB's preliminary safety assessments presented during the development of the KBS-3 method,
- consultation meetings between SKB and SSM (and its predecessors) concerning site investigations and the content of SKB's safety reporting.

As part of the review of the RD&D programmes, the authorities have provided review comments and requested clarifications related to a gradual modification and refinement of barrier design and rock excavation and the reference methods utilized for construction and manufacturing activities. However, no definitive judgments regarding the acceptability of design options and manufacturing processes have been made during these pre-licensing reviews since the responsibility for development of the KBS-3 method rests entirely with the implementer.

A key requirement on the implementer stated in the Swedish Act on Nuclear Activities is that the RD&D programmes should be sufficiently broad in scope. Based on this requirement and other regulatory requirements related to the use of best available technique, SSM and its predecessors have requested additional reporting from SKB, e.g. regarding the disposal of spent nuclear fuel in deep boreholes as a basis for comparison with the KBS-3 method. Such requests have also been made during the ongoing licensing review, including a request for complementary information related to new scientific knowledge of conditions at great depth in the bedrock, recently proposed modified concepts for deep borehole disposal as well as a more detailed discussion of the different barrier functions

that can be accounted for in the deep borehole disposal option, see section G.5.3.2. The information about deep boreholes is needed for justification of SKB's KBS-3 method as best available technique.

SSM and its predecessors, SKI and SSI, have evaluated the safety implications of the proposed KBS-3 method for disposal of spent nuclear fuel by reviewing a number of preliminary safety analysis reports produced by SKB during earlier stages of the repository development programme, see section G.4.2.3. The authorities have devoted considerable review resources to evaluate the suitability of safety assessment methods, scientific and technical issues related to the engineered and natural barriers, including the long-term behaviour of copper canisters and the bentonite buffer, as well as construction activities in the bedrock. Based on these reviews the authorities have regularly provided feedback to SKB on their development of a repository system for spent nuclear fuel.

In order to develop an independent safety assessment capability, SKI also carried out two safety assessments of the KBS-3 disposal method (Project-90 and SKI SITE-94, see *www.ssm.se*). The reports from these regulatory safety assessments and the report on SKB's preliminary safety assessment SR-97 were subjected to international peer review organised by the OECD's Nuclear Energy Agency (NEA). For the regulatory review of SKB's SR-Can safety report[16], SKI and SSI set up three independent external expert groups in 2006 covering the evaluation of different aspects, such as the implementation of site-specific information, handling of engineered barrier issues and the safety assessment methods utilized by SKB.

G.4.4 Conclusion

Sweden complies with the obligations of Article 7.

[16] SR-Can was the last preliminary post-closure safety analysis of the KBS-3 disposal method carried out by SKB prior to developing the SR-Site safety analysis that supports their licence application for a spent nuclear fuel repository.

G.5 Article 8: ASSESSMENT OF SAFETY OF FACILITIES

"Each Contracting Party shall take the appropriate steps to ensure that:
(i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;
(ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i)."

G.5.1 Regulatory requirements

G.5.1.1 Assessment of safety

Requirements on safety assessment, safety review and reporting are listed in the regulations concerning safety in nuclear facilities (SSMFS 2008:1) and apply to the operation of all types of nuclear installations, including facilities for treatment, storage and disposal of spent fuel and radioactive waste. The basic provisions regarding safety assessment and review can be summarised in the following points:

Safety Analysis
Analyses of conditions of importance for the safety of a facility shall be carried out before a facility is constructed and taken into operation. The analysis shall subsequently be kept up-to-date. The safety analyses shall be based on a systematic inventory of such events, event sequences and conditions that could lead to a radiological accident.

Safety Report
A preliminary safety report shall be prepared before a facility may be constructed. The safety report shall be updated before trial operation of the facility may be started. The safety report shall be supplemented before the facility is taken into routine operation. The safety report shall thereafter be kept up-to-date. The content of the safety report is specified in the regulations SSMFS 2008:1. Before the facility may be constructed and taken into operation, the safety report shall be evaluated and approved by SSM. The safety report shall subsequently be kept up-to-date. In the update of the regulations it has been clarified that the safety report (SAR) shall reflect the plant as built, analysed and verified and show how the valid safety requirements are met. Plant modifications shall be assessed against conditions described in the SAR. It has also been clarified that all plant structures, systems and components of importance for the defence-in-depth shall be described in the SAR, not only the safety systems. New safety standards and practices, which have been assessed by the licensee and found applicable, shall

be documented and inserted into the SAR as soon as corresponding modifications or other plant measures have been taken. A few additional requirements on the content of the SAR have also been added.

Safety Review
A safety review shall determine or check that the applicable safety-related aspects of a specific issue have been taken into account and that appropriate safety-related requirements with respect to the design, function, organisation and activities of a facility are met according to SSMFS 2008:1. The review shall be carried out systematically and must be documented. A safety review shall be performed within those parts of the organisation responsible for the specific issues ("primary review"). A second safety review shall be performed by a safety review function appointed for this purpose and which has an independent position relative to those parts of the organisation responsible for the specific issues ("secondary review").

Safety Programme
After it is taken into operation, the safety of a facility shall be continuously analysed and assessed in a systematic manner. Any need for improvement regarding safety measures, engineering or organisational issues and which arise as a result of such analyses and assessments, shall be documented in a safety programme. The safety programme shall be updated on an annual basis.

Periodic Safety Review of Facilities
At least once every ten years, a new and integrated analysis and assessment of the safety of a facility shall be performed. The analyses and assessments, as well as the measures proposed on the basis of these, must be documented and submitted to SSM. Since 2010, the requirement regarding Periodic Safety Reviews (PSR) is stated in the Act on Nuclear Activities. The PSR should cover both nuclear safety and radiation protection with the purpose of clarifying how requirements stated in relevant legislation as well as issued regulations and conditions are met and are expected to be met over the following period of ten years. The reviews will also be used for assessment of time-limited licensing conditions.

Modifications
A safety review shall be performed for engineering or organisational modifications to a facility, which can affect the conditions specified in the safety report as well as essential modifications to the report. Before the modifications may be included in the report, SSM shall be notified and can determine that additional or other requirements or conditions shall apply with respect to the modifications.

Post Closure Safety
Additional requirements concerning the long-term term radiation protection and nuclear safety of a disposal facility are stipulated in the regulations concerning safety in connection with the disposal of nuclear material and nuclear waste (SSMFS 2008:21) as well as regulations and general advice on the protection of human health and the environment in connection with the final management of spent nuclear fuel and nuclear waste (SSMFS 2008:37).

The regulations SSMFS 2008:21 contain requirements on the design of the repository, barrier functions and safety reporting. The safety assessment for a

disposal facility shall comprise features, events and processes that can lead to the dispersion of radioactive substances after closure. Such safety assessments are requested as a basis for applications for construction, operation and closure. The safety assessment shall cover the length of time for which barrier functions are required, though at least ten thousand years.

The regulations SSMFS 2008:37 comprise basic requirements on protection of human health (expressed as a risk target), general environmental protection goals and on the application of optimisation and Best Available Technique (BAT). The corresponding guidance gives advice on reporting for different time periods after closure, selection of scenarios, calculation of risk, dealing with uncertainty and risk dilution.

G.5.1.2 Environmental assessment

According to the requirements of the Act on Nuclear Activities, an EIA shall be prepared for an application under the Act. These are the same requirements as stated in the Environmental Code.

The Environmental Code also contains the detailed requirements on what an EIA should contain and how to prepare it, see also section E.2.2.4.

The purpose of an EIA is to establish and describe the direct and indirect impacts of a planned activity or measure as listed below. An environmental impact statement shall contain the following information:

- a description of the activity or measure with details of its location, design and scope;
- a description of the measures being planned with a view to avoiding, mitigating or remedying adverse effects, for example action to prevent the activity or measure leading to an infringement of an environmental quality standard;
- the information that is needed to establish and assess the major impact on human health, the environment and the management of land, water and other resources that the activity or measure is likely to have;
- a description of possible alternative sites and alternative designs, together with a statement of the reasons why a specific alternative was chosen as well as a description of the consequences if the activity or measure is not implemented; and
- a non-technical summary of the information.

G.5.1.3 The licensing procedure

Three different permits/licences are required for a nuclear facility: a permit under the Environmental Code, a licence under the Act on Nuclear Activities, and a building permit under the Planning and Building Act. A separate licence under the Radiation Protection Act is not needed for an activity that is licensed under the Act on Nuclear Activities.

Licensing under the Environmental Code and the Act on Nuclear Activities occurs in parallel. The applications under both enactments must include an environmental impact statement (EIS). Separate environmental impact statements are prepared for the encapsulation plant and the disposal facility for spent nuclear fuel. According to the Environmental Code, the Government shall, after preparation by the Land and Environmental Court, examine the permissibility of

the activity (Chapter 17). After SSM's preparation of the matter, the Government shall also examine permit applications under the Act on Nuclear Activities. If the Government finds that the siting, construction and operation of the facility is permissible according to the Environmental Code and grants a licence under the Act on Nuclear Activities, the next step is for the Land and Environmental Court to grant a licence and stipulate conditions in accordance with the Environmental Code. After a licence has been granted according to the Act on Nuclear Activities, SSM may issue further conditions according to the Radiation Protection Act or the Act on Nuclear Activities.

G.5.2 Measures taken by the licence holders

G.5.2.1 Safety Assessments

General information

For more than 25 years now, the Swedish Radiation Safety Authority and its predecessors (the Swedish Nuclear Power Inspectorate, SKI, and the Swedish Radiation Protection Authority, SSI) have been reviewing SKB's development work, and in particular, SKB's tri-annually submitted RD&D programme involving research, development and demonstration work. The results from the reviews of the RD&D programmes have been delivered to the Government for decisions on the programmes. This iterative procedure has formed an open and transparent process for all the involved organisations and interested stakeholders. It has also given valuable feedback for the work of SKB and has increased the knowledge base for all involved actors.

In March 2011 SKB applied for a permit to build a repository for spent nuclear fuel and the encapsulation plant where the fuel will be encapsulated before being transported to the repository. The application from 2011 has later been supplemented with information requested by SSM during its review of the application. All the information is public and is part of the open and transparent iterative Swedish process. The licensing review is still ongoing.

Construction of nuclear facilities requires permits in accordance with the Swedish Environmental Code and the Act (1984:3) on Nuclear Activities. Both enactments require SKB to report on the planned operations. The Act on Nuclear Activities states that this report must address radiation protection and short and long term nuclear safety. The Environmental Code specifically requires a description of the potential impact of the planned operations on human beings and the environment. The Act on Nuclear Activities requires an equivalent impact assessment.

Purpose

The main purposes of the safety assessment project SR-Site are to:

- assess the safety, as defined in applicable Swedish regulations, of the proposed KBS-3 repository at Forsmark, and to
- provide feedback for design development, to SKB's RD&D programme, for detailed site investigations and for future safety assessment projects.

The safety assessment work has been performed in a stepwise manner. An important step leading up to the present report was the preparation of the SR-

Can safety assessment report, published in November 2006. The SR-Can report was reviewed by the Swedish safety authorities aided by a group of international experts, and the outcome of the review has been taken into account in the SR-Site assessment. After the submission of the SR-Site assessment as part of the licence application in 2011, complementary information has been supplied by SKB as responses to questions from SSM during its review work.

Summary of results
The implementer's, i.e. SKB's, central conclusion of the safety assessment SR-Site is that a KBS-3 repository that fulfils long-term safety requirements can be built at the Forsmark site. This conclusion has been drawn because the favourable properties of the Forsmark site ensure the required long-term durability of the barriers of the KBS-3 repository. In particular, the copper canisters with their cast iron inserts have been demonstrated to provide sufficient resistance to the mechanical and chemical loads to which they may be subjected in the repository environment.

According to SKB, this conclusion is underpinned by:
- The reliance of the KBS-3 repository on i) a geological environment that exhibits long-term stability with respect to properties of importance for long-term safety, i.e. mechanical stability, low groundwater flow rates at repository depth and the absence of high concentrations of detrimental components in the groundwater, and ii) the choice of naturally occurring materials (copper and bentonite clay) for the engineered barriers that are sufficiently durable in the repository environment to provide the barrier longevity required for safety.
- The understanding, through decades of research at SKB and in international collaboration, of the phenomena that affect long-term safety, resulting in a mature knowledge base for the safety assessment.
- The understanding of the characteristics of the site through several years of surface-based investigations of the conditions at depth and of scientific interpretation of the data emerging from the investigations, resulting in a mature model of the site, adequate for use in the safety assessment.
- The detailed specifications of the engineered parts of the repository and the demonstration of how components fulfilling the specifications are to be produced in a quality assured manner, thereby providing a quality assured initial state for the safety assessment.

Furthermore, SKB argues that the detailed analyses demonstrate that canister failures in a one million year perspective are rare. Even with a number of pessimistic assumptions regarding detrimental phenomena affecting the buffer and the canister, they would be sufficiently rare.

Future development of the repository programme
The design and safety evaluation of a repository concept for geological disposal such as the KBS-3 system are developed in steps, where a safety evaluation in one step provides feedback for the development of repository design. The developed design is then evaluated in a subsequent safety assessment, which provides refined feedback for the further development of the design, etc. Likewise, the understanding of natural processes of importance for long-term safety is developed in an RD&D programme and the emerging findings are evaluated in an iterative interaction with

safety assessment projects. Another important aspect of this iterative nature of the development is the external reviews, by authorities and international experts, of the safety assessments.

SKB has conducted research and development of the KBS-3 system for three decades now and according to SKB both the repository design and the scientific knowledge are mature. As manifested by the fact that no major design changes have occurred in recent years and that the identified set of processes of importance for long-term safety is stable, as is the knowledge about the processes.

SKB has established a technically feasible reference design and layout of the KBS-3 repository and showed that this conforms to the established design premises (see below), but technical development will continue. Detailed designs adapted to an industrialised process designed to fulfil specific requirements on quality, cost and efficiency still need to be developed. The layout needs to be adapted to the local conditions found when constructing the repository at depth. These potentially more optimal solutions should result in at least the same level of safety as the current reference design being assessed in the safety assessment SR-Site. Since SR-Site is an important basis for a critical decision point in the repository programme, it is essential to demonstrate:

- that the essential safety-related features of the design are mature, and
- that there is at least one available and adequate option for parts of the system that are more peripheral in terms of contributing to safety.

Another characteristic of the present situation emphasised by SKB is that the well-established parts of the design are specified in detail; the feedback for design development from the safety assessment preceding SR-Site (the SR-Can assessment) is given in the form of detailed design premises that have served as input to specifications of the reference design and facilitated the evaluation of the appropriateness of the design with respect to long-term safety. Measures taken for an environmental impact statement (EIS) are described in section G.3.2.

Newfound knowledge since publication of the 4th Swedish National Report to the Joint Convention

As far as methods for uncertainty and sensitivity analysis are concerned, development of tools for variance-based sensitivity analysis is underway. This powerful method for ascertaining which uncertain input data parameters have the greatest impact on uncertainties in a probabilistic calculation result is suitable for problems that can be handled with a fast calculation model, since the method requires a large number of model realizations to be carried out. Since SKB has previously developed fast analytical calculation models for radionuclide transport, the necessary conditions exist for using variance-based sensitivity analysis on the results of these models. After further simplifications, the calculation model can be made so fast that the variance-based sensitivity analysis can be carried further than is normal within other areas. Development is continuing, and it should be possible to apply the method if needed to calculation results from both numerical and analytical models for radionuclide transport in the PSAR.

G.5.2.2 External reviews

The post-closure safety report, SR-Site, supporting SKB's safety case in the licence application, was subjected to an international peer review organised by OECD's Nuclear Energy Agency during 2011-2012. The remit of the peer review

was to provide an independent assessment on the maturity of SKB's post-closure safety case and to determine if it is on a par with international state-of-the-art.

The overall conclusion of the peer review was that SKB's post-closure safety report is sufficient and credible for the decision at hand and that SKB generally gives a convincing illustration and technical basis both for the feasibility of the future repository, according to the KBS-3 design, and for its radiological long-term safety. However, the expert team also gave a number of recommendations for additional research and improvements that are needed for the safety cases supporting the next licensing steps. The team also underscored that the progression from the conceptual phase of SKB's repository project to an implementation phase means that the industrial feasibility of the barriers and of the repository, including assurance of their quality, will become increasingly important.

G.5.3 Regulatory control

G.5.3.1 Introduction

On 16 March 2011 the Swedish Nuclear Fuel and Waste Management Company (SKB) submitted licence applications for a general licence to construct, own and operate a KBS-3 type spent nuclear fuel repository at the Forsmark site, in Östhammar Municipality, and an encapsulation plant, in Oskarshamn Municipality. The KBS-3 method entails disposing of the spent fuel in copper canisters, surrounded by a swelling bentonite clay, at about 500 metres in depth in crystalline basement rock, see Figure A11.

As described in section G.5.1.3, SKB's applications are being evaluated in parallel by the Swedish Radiation Safety Authority (SSM) under the Act on Nuclear Activities and by the Land and Environmental Court under the Environmental Code, see also Figure G2. During the review SSM will act as an expert review body in relation to the Land and Environmental Court in the areas of radiation protection, safety and security/non-proliferation. Both SSM and the court will produce a statement with a recommendation to the Government regarding a licensing decision and licensing conditions. The Government will make the final decision after consulting the relevant municipalities affected by SKB's facilities (municipal veto applies).

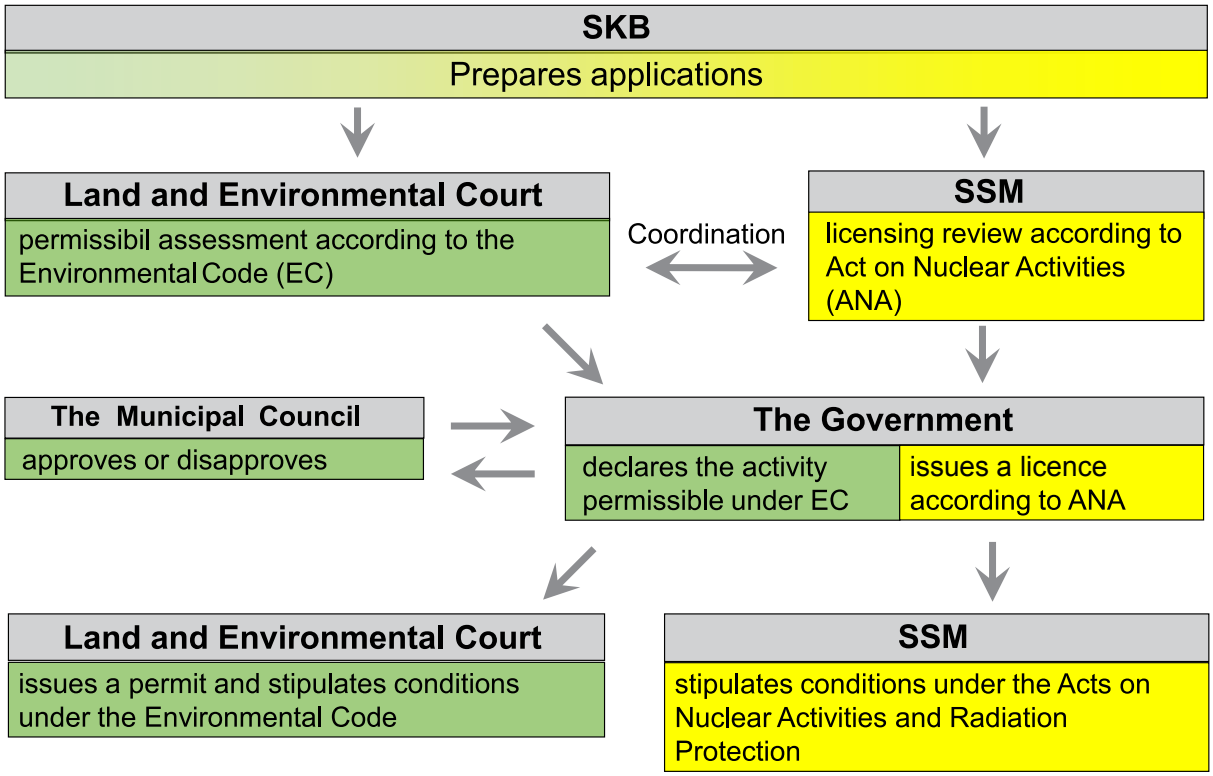

Figure G2: The procedure for the licensing of SKB's licence application for a spent nuclear fuel repository and an encapsulation plant.

The current licensing decision is just one of several licensing decisions that will be required for the repository. However it is arguably the most important one, because it is the last licensing stage with a broad societal involvement including an Environmental Impact Assessment (EIA) process, national consultations and municipal veto for the municipalities concerned. The licensing steps to follow, should SKB be granted a licence by the Government, will require approval by SSM. These steps include application for the start of actual construction work, test operation and routine operation.

G.5.3.2 Ongoing licensing review

Since SKB's submission of its licence applications in 2011, SSM has been conducting a licensing review to determine if the proposed repository for spent nuclear fuel at the Forsmark site and an encapsulation plant in the municipality of Oskarshamn have the potential to fulfil SSM's regulatory requirements (SSMFS 2008:1; SSMFS 2008:21; SSMFS 2008:37). The review has been set up as a project with participation from all of SSM's departments. The main aspects of SKB's application are:

- post-closure repository safety,
- safety during construction and operation of the repository,
- encapsulation plant operational safety, and
- suitability of the overall repository system.

SSM's licensing review is divided into an initial review phase and the main review phase with the associated reporting phase, see Figure G3. The initial review phase started with SKB's submission of its licence applications in March 2011 and was completed with a statement on completeness of SKB's applications to the Land and Environmental Court in the autumn of 2012.

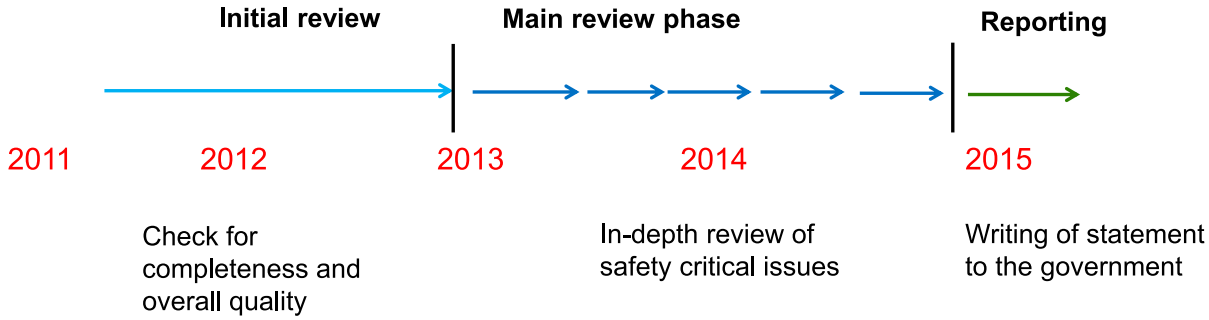

Figure G3: Schedule for SSM's licensing review.

The objectives of the initial review phase were to conduct a broad review of all primary licensing documents of SKB's safety case in order to make a first assessment of the quality and completeness of SKB's application, to identify scientific and technical areas for an in-depth review in the coming main review phase, and to develop requests for complementary information from SKB. SSM's initial review phase comprised the following activities:

- Public procurement of external experts.
- Document review by SSM staff and external experts covering the post-closure safety report SR-Site with supporting references.
- First round of SSM's independent modelling.
- First round of a national consultation of SKB's licence application.
- An international peer review of SKB's licence application organised by OECD's Nuclear Energy Agency (NEA) on request by the Swedish Government.
- Development of requests for complementary information.
- Development of a statement on completeness of SKB's applications to the Land and Environmental Court.

SSM's overall conclusion from the initial review phase was that SKB's reporting is sufficiently comprehensive and of sufficient quality to justify a continuation of SSM's review. However, SSM identified a number of both technical and scientific issues requiring complementary information from SKB for the in-depth review of the main review phase. Some examples of areas covered by SSM's requests for complementary information are:

- Long-term canister integrity.
- Site-specific conditions at the Forsmark site.
- Safety reporting for the encapsulation plant.
- Plans for demonstration of technical implementation of repository technology.
- Justification of the proposed direct disposal method in relation to alternative methods such as very deep borehole disposal and possible reuse of the spent nuclear fuel in Generation-4 reactors.

There is a range of review results that can be accessed through SSM's website (www.ssm.se) including the following: 35 Technical Notes documenting the review findings of SSM's external experts, a large number of requests for complementary information and responses from SKB, review comments from the national consultation, the final report of the international peer review organised by OECD/NEA and a statement to the Land and Environmental Court on completeness of SKB's applications.

The main review phase that started in January 2013 involves an in-depth review with resolution of the safety critical review issues identified in the initial review phase. It will continue until all review issues of importance for the compliance evaluation have been resolved. The main review and reporting phases comprise:

- A structured resolution of remaining review issues based on complementary information from SKB and support from SSM's external experts.
- A second round of SSM's independent modelling.
- A second round of the national consultation.
- Development of a second review statement to the Land and Environmental Court.
- Development of a review statement with a recommendation for a licensing decision to the Swedish Government.

By February 2014, SKB had responded to almost all of SSM's requests for complementary information, but some supporting information is still in the process of being developed, e.g. related to the canister degradation processes and operational safety of the encapsulation plant. SSM cannot presently rule out the need to submit additional requests for complementary information.

In order to promote openness and broad public participation in the licensing review, SSM has organised two rounds of broad national consultation of SKB's licence applications. In the first round, carried out during the initial review phase, SSM requested views primarily on the overall quality and completeness of SKB's applications. SKB's applications were sent to a total of 67 organisations including the involved municipalities and county boards, environmental organisations and other non-governmental organisations, universities, and other authorities. The first step of the national consultation was completed during the initial review phase during which the respondents were given the opportunity to identify the need for additional information from the applicant. The second round of the national consultation, to be carried out during 2014, will focus on factual circumstances affecting repository long-term safety, radiation protection and environmental protection.

According to the current time schedule, SSM should submit review findings to the Swedish Land and Environmental Court during the first half of 2015 for their main hearing. After the hearing has been completed, SSM will provide an updated report with a recommendation for a licensing decision to the Swedish Government in 2016 according to the present review plan.

G.5.3.3 Public procurement of external expert support

The Swedish Public Procurement Act requires a strictly formal competitive procedure for the commissioning of external experts to be used by the Authority during a licensing review. Experts are engaged through publicly announced invitations to submit tenders. It was a challenge for SSM to adopt such formal

procedures during the early phase of the licensing review. Prior to the licensing review, external experts had mostly been commissioned as researchers in joint research projects. The procurement procedure was much more time consuming than anticipated and many complicated issues related to competence requirements and impartiality requirements had to be resolved. However, the experiences have been very valuable in that they have provided a basis for more effective routines on procurement and a more transparent and predictable use of external experts in the future.

G.5.4 Conclusion

Sweden complies with the obligations of Article 8.

G.6 Article 9: OPERATION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:
(i) the licence to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;
(ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;
(iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;
(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;
(v) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;
(vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;
(vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

G.6.1 Regulatory requirements

The general regulations concerning safety in nuclear installations (SSMFS 2008:1) contain legally binding requirements relevant for all the obligations of Articles 9 and 16. These requirements are summarised below.

G.6.1.1 Initial authorisation

As mentioned in section G.5, a preliminary comprehensive safety report is required before the construction of a spent nuclear facility. A complete safety report, which also takes into account the results from commissioning tests, is required before the facility is taken into operation.

G.6.1.2 Operational limits and conditions (OLCs)

Documented up-to-date Operational Limits and Conditions (OLCs) are required containing the necessary operational limits and conditions, as further specified in a separate appendix to the regulations. The OLCs shall together with the operating procedures ensure that the conditions postulated in the safety report are maintained during the operation of the facility. The OLCs shall be subjected to a twofold safety review by the licensee and submitted to the regulatory authority

for approval. The licensee shall notify the regulatory authority about any changes after they have been subjected to a twofold safety review.

G.6.1.3 Established procedures

Suitable, verified and documented procedures are required for all operational states including accidents. The procedures for operability verification and procedures used in operational states other than normal operation shall be subjected to a twofold safety review by the licensee. Procedures for maintenance important for safety are also covered by the requirement. Maintenance programmes shall be documented. Inspection and testing of mechanical components shall be carried out according to qualified methods and verified procedures.

G.6.1.4 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. 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 be available in-house for ordering, managing and evaluating the results of contractors' work of importance for safety.

G.6.1.5 Reporting of incidents in a timely manner

The general regulations concerning safety in nuclear installations (SSMFS 2008:1) contain one chapter about reporting requirements and an annex specifying these requirements for various types of events. The following is a brief account:

- Reporting within 1 hour: 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 and the occurrence of any abnormal events or disturbances, also requirements on a comprehensive annual report summarising all experience important for the safety of the plant. Specifications are given about the content of the different reports and further interpretation of the reporting requirements is given in the general recommendations. In one of the basic paragraphs of SSMFS 2008:1, 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, performance of safety reviews and reporting to SSM. 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:

- 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 during the period of time when corrective action is being taken and 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 all three cases, corrective measures shall be subject to a twofold safety review by the licensee. The results of these reviews shall be submitted to SSM. Regarding category 3 events, there is no requirement to submit a specific report to SSM. It is sufficient to provide a compilation of these events in the annual report.

G.6.1.6 Programmes for collecting and analysing operating experience

The licensee shall ensure that experience from its own facilities and from similar activities in other relevant facilities is continuously analysed, used and communicated to the personnel concerned (SSMFS 2008:1). It is further required that all events and conditions which are detected and which are important for 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. Under SSMFS 2008:1, it is the responsibility of the licensee, for as long as the disposal facility is in operation, to remain continuously informed of the conditions of importance for the assessment of disposal facility safety, also after closure.

G.6.1.7 Decommissioning plans

Decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

Regulations set out a number of specific requirements relating to decommissioning, including:
- A preliminary plan for the future decommissioning of the facility to be compiled before construction of a facility;
- Safety and radiation protection at the time of decommissioning shall be taken into account during the construction of a facility and before changes are made in an existing facility;
- The preliminary plan shall be supplemented and kept up to date for the duration of the facility's operation and shall be reported to SSM every ten years;
- During the operation of a facility, observations and events that have significance for planning and execution of decommissioning shall be documented on an ongoing basis;

- When a decision has been made on final shutdown of a facility within a certain period of time, an integrated analysis and assessment of how safety is to be maintained during the time remaining until the facility's closure shall be conducted without delay. An analysis and assessment of organisational changes during the closure period and personnel requirements during decommissioning shall also be performed. The analyses, assessments and measures emanating from these shall be documented and reported to SSM.

For further information see section F.6.1.

G.6.2 Measures taken by the licence holders

The general safety regulations (SSMFS 2008:1) contain legally binding requirements relevant for all obligations of Article 9. These requirements are summarized below.

G.6.2.1 Initial authorisation

No spent nuclear fuel facility has been commissioned since 1985, when the central interim storage facility for spent fuel (Clab) was taken into operation. The application procedure for the extension works to increase the storage capacity from 5,000 to 8,000 tonnes of uranium was the first time the modernized legislative and regulatory system was implemented.

Although neither the Environmental Code, SSM's regulations SSMFS 2008:1 and 2008:21 nor the Radiation Protection Act had been issued at the time of the application, the formal procedure to initiate the project was run according to procedures later established by the issuance of those documents, as described in sections E2, E3 and G3.

The siting processes for the encapsulation plant and the repository for spent nuclear fuel were initiated in accordance with the procedures outlined in this document. The procedure is described in detail in section G.3.2.

G.6.2.2 Operational limits and conditions (OLCs)

The operational limits and conditions for nuclear facilities are described in the operational limits and conditions (OLC), a document which is considered to be one of the cornerstones in the governing and regulation of the operation of Swedish nuclear activities. Every OLC is facility-specific and is approved by SSM as part of the licensing conditions.

The original OLC for each facility is derived from the safety analyses in the SAR, in which the behaviour of the facility is described. Correction and updating take place when new and better knowledge is available, either from research, tests or operational experience. Suggestions for changes in OLC are reviewed carefully from the safety point of view at different levels in the operating organisation and are ultimately approved by the regulatory body before they are included in the document.

The fact that OLC is reviewed and revised regularly has contributed to making it a living document. It is also part of the quality and management system and used frequently in particular by the operations staff. An essential part of OLC is the general clause that says that "...should any doubt appear about the interpretation of the text, the general purpose of OLC shall be guiding. This means that the facility in all indefinite situations shall be maintained or brought respectively to a safe

state." Other parts of OLC are the descriptive background to the document. The background description is important for preserving and transferring to new staff the knowledge and experience of those who participated in the original production of OLC. Modified and maintained equipment must pass an operability test to verify that the equipment fulfils specified operational requirements before being accepted for continuous operation.

G.6.2.3 Established procedures

All activities that directly affect the operation of the facility are governed by procedures of different kinds covering normal operation, emergency operation and functional tests. Maintenance activities according to an approved maintenance programme are also to a great extent accomplished according to procedures, however, not always as detailed as the operating procedures, in which activities are described in sequences step by step. Signing off the completion of steps carried out in the procedures is mandatory in most cases in order to confirm the completion and facilitate verification.

The development of procedures follows specified directives, which include the reviewing of the documents, normally by more than one person other than the author before being approved by the operations manager or someone else at the corresponding level. The same applies to revision procedures. Revision procedures are to be carried out continuously, in particular maintenance procedures, when new experience is obtained. Emergency procedures have been developed in order to deal with anticipated operational events.

G.6.2.4 Engineering and technical support

The principles for staffing are reported in section F2.

Competences that might not be completely available within the own organisation at all plants are for instance expertise and resources for materials and chemistry assessments, radiation shielding and environmental consequence calculations, expertise and resources for software for safety applications and also process control and measurement techniques. The IT functions in particular have normally been outsourced, but are still available on-site. The intention is always to have the purchasing competence within the operating organisation, as well as the capability of evaluating the results of analyses, calculations, etc. performed by consultants.

G.6.2.5 Reporting of incidents in a timely manner

Incidents significant to safety are reported according to the non-routine reporting requirements in the technical specifications, see section G.6.1.5. There are two types of licensee event reports (LER). The more severe one, called abnormal event, requires the facility to inform SSM within an hour. A final report shall be submitted within ten days from the time of the event and the analysis of the event and appropriate measures to prevent recurrence shall be approved by SSM. Only a very limited number of events of this category have occurred at the Swedish facilities over the years; in the waste and spent fuel facilities, none have occurred. These events would typically also be of such a level of severity so as to warrant reporting in accordance with the International Nuclear Event Scale (INES).

The other type of LER, called RO (Reportable Occurrence), is used for less severe events. This type of event is mentioned in the weekly report, which is sent

to the regulatory bodies, followed up by a final report within 30 days. The reports are reviewed at different levels within the operating organisation and approved by the operations or production manager before submission.

The front of the standardized report form describes the event in general: identification number, title, reference to OLC, date of discovery and length of time until corrective actions were completed, conditions at the time of occurrence, system consequences, a contact person at the plant and activities affected by the event. On the reverse side of the document a description of the event is given. The following headings are used:

- event course and operational consequence,
- safety significance,
- direct and root causes,
- planned/decided measures, and
- lessons learned by the event.

If the description of the event is extensive, additional pages may be attached to the form. Reports are also required in accordance with OLC when the permitted levels of activity release from the facility are exceeded, or in the event of unusually high radiation exposure to individuals. These types of non-routine reporting are primarily directed towards SSM.

G.6.2.6 Programme for collecting and analysing operating experience

The objective of the analysis and feedback programme concerning operating experience is to learn from one's own and others' experience and thus prevent recurrences of events, particularly those that might affect the safety of the facility. The operating experience feedback process consists of a wide variety of activities within the plant organisation as well as externally.

G.6.2.7 Decommissioning plans

Before a facility may be constructed, a decommissioning plan shall be drawn up for the future decommissioning of the facility. The degree of detail in the plan increases as the time for decommissioning approaches. The plan shall be supplemented and kept up to date for as long as the facility is in operation and shall be presented to SSM together with the periodic safety reviews.

The decommissioning plan contains, among other things, a facility description, a plan for the decommissioning activities and plans for management and disposal of radioactive waste. Before a dismantling operation may commence, the decommissioning plan must be supplemented and presented to SSM. The safety analysis report for the facility must be supplemented according to the activities planned in the facility. The revised safety analysis report shall be reviewed and approved by SSM.

All licensees for the Swedish NPPs, with the exception of Barsebäck, have updated their decommissioning plan during 2013. The decommissioning plan for the units in Barsebäck was revised and submitted to SSM in 2012.

SKB is the licensee for Clab and will likewise be the licensee for the integrated facility called Clink when the addition containing the planned encapsulation plant is finished. The existing decommissioning plan for Clink is under revision

and will be communicated to SSM in 2014. A decommissioning plan has been prepared for the spent fuel repository and was included in the application under the Act (1984:3) on Nuclear Activities for disposal of spent nuclear fuel and under the Environmental Code for the KBS-3 system. A decommissioning plan for the extended SFR has been prepared for the application under the Act (1984:3) and under the Environmental Code for authorizing the extension and continued operation of SFR.

G.6.3 Regulatory control

G.6.3.1 Initial authorisation

The regulatory control is achieved through the procedures described in sections E.2.3.1 and E.2.3.3.

G.6.3.2 Operational limits and conditions

SSM reviews applications for changes in OLC, and for exemptions from OLC. Based on the application and information provided by the licensees, and the associated safety analyses, assessments are made about how the proposed changes or exemptions contribute to the risk profile of the facility.

G.6.3.3 Procedures

Operational and maintenance procedures are normally not reviewed by SSM. Only in connection with event investigations would SSM ask for a procedure to be submitted for review. SSM has looked into the routines used for updating procedures in the framework of quality assurance inspections or review of quality audits made by the licensees (see section F.3).

G.6.3.4 Engineering and technical support

SSM has not thus far specifically inspected the engineering and technical support available at the facilities. In connection with other inspections and reviews, the staffing situation has occasionally been commented upon.

G.6.3.5 Incident reporting

Licensee event reports are reviewed upon arrival by the site inspector responsible, who asks the facility for clarification if necessary. As a routine, all LERs are screened once a week by a permanent group of inspectors and specialists in order to assess the event, the analysis and the measures taken by the licensees. If there have been any regulatory concerns, the issue is brought up at a management meeting and a decision made about any further measures to be taken by SSM.

G.6.3.6 Experience feedback analysis

The regulatory control is achieved through the procedures described in section E.2.3.3. The experience feedback programme is followed up by the regulator in connection with event investigations and other inspections and reviews.

G.6.3.7 Decommissioning plans

The updated decommissioning plan shall be further developed and the revised

plan reported to SSM. Also, the facility's safety analysis report shall be supplemented in accordance with the revised plan. A safety review of the revised safety analysis report shall be performed by the licence holder and the report shall be reviewed and approved by SSM before dismantling and demolition commence.

G.6.4 Conclusion

Sweden complies with the obligations of Article 9.

G.7 Article 10: DISPOSAL OF SPENT FUEL

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

G.7.1 Regulatory requirements

- According to the Act on Nuclear Activities, the following definitions apply:
- spent nuclear fuel which has not been disposed of in a disposal facility is defined as nuclear material; and
- spent nuclear fuel which has been disposed of in a disposal facility is defined as nuclear waste.

Reprocessing is not part of the back end of the nuclear fuel cycle in Sweden, as described in section C, and the policy and practices for management of spent nuclear fuel are direct disposal, as described in section B.

It is also clearly stated in the general obligations in the Act on Nuclear Activities (Section 10) that the holder of a licence for nuclear activities shall be responsible for ensuring that all measures are taken needed for:

- maintaining safety, with reference to the nature of the activities and the manner in which they are conducted, and
- ensuring the safe handling and disposal of nuclear waste arising from the activities or nuclear material arising therein that is not reused.

G.7.2 Measures taken by the licence holders

The practical implication is that spent fuel is in practice treated as high level radioactive waste.

G.7.3 Conclusion

Sweden complies with the obligations of Article 10.

The general safety requirements presented in section G are essentially the same as those for radioactive waste management under section H. Parts that are common to both section G and section H have been presented in section G only, and thus been referred to in section H. To the extent the requirements differ between safety of spent fuel management and safety of radioactive waste management, this is stated under the respective section. The programme for radioactive waste repositories is described in this section, whereas the development of a geological disposal facility for spent nuclear fuel is described in section G.

H.1 Article 11: GENERAL SAFETY REQUIREMENTS

Each Contracting Party shall take the appropriate steps to ensure that at all stages of radioactive waste management individuals, society and the environment are adequately protected against radiological and other hazards. In so doing, each Contracting Party shall take the appropriate steps to:

(i) ensure that criticality and removal of residual heat generated during radioactive waste management are adequately addressed;
(ii) ensure that the generation of radioactive waste is kept to the minimum practicable;
(iii) take into account interdependencies among the different steps in radioactive waste management;
(iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;
(v) take into account the biological, chemical and other hazards that may be associated with radioactive waste management;
(vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;
(viii) aim to avoid imposing undue burdens on future generations.

H.1.1 Regulatory requirements

H.1.1.1 The general obligations of licence holders

See section G.1.1.1.

H.1.1.2 Basic provisions and licence obligations

For regulations that apply to both spent fuel and radioactive waste from nuclear facilities, see section G.1.1.2. The following regulations only apply to radioactive waste from nuclear facilities.

Identification of radioactive substance content in nuclear waste
The radioactive substance content of nuclear waste that without further handling at the facility is to be transferred to a repository, or which is intended to be stored for a period of time exceeding two years, shall be identified through nuclide-specific measurement. In cases where this is neither feasible nor possible, the radioactive substance content may be determined in some other way. Prior to measurement and registration, the waste is to be classified into items corresponding to waste packages, components, containers or other unit matching the material in question and which enables a reliable identification of the activity content. Requirements imposed on nuclide identification must be stated in the safety analysis report.

Records of nuclear waste
The facility shall have records available on the items of nuclear waste generated at the facility or present at the facility. To the extent that is feasible and possible, these records must be kept up to date. Each registered waste item is to be clearly marked for identity purposes. The records must also contain information about the management of each waste item that has left the facility. For each waste item, the records must provide information about:

1. the waste item's identity (marking),
2. the corresponding type description or separate description of the waste (when applicable),
3. the origin of the nuclear waste or from which part(s) of the facility the nuclear waste has come,
4. the nuclear waste's previous treatment, if any, and present physical and chemical form,
5. quantity,
6. nuclide-specific content of radioactive substances, with reference date and uncertainty in terms of the nuclide content,
7. external radiation level, with distance and reference date,
8. position in the storage facility or repository, and
9. the date of treatment performed: for nuclear waste intended to remain at the facility for a period of time exceeding two years, the records shall also provide information about the time schedule for the ongoing management.

Reporting
A report concerning the past calendar year shall be sent to SSM. The report shall comprise a summary of:

1. the amount of waste that has arisen or by other means has been brought to the facility;
2. waste that has been transferred to disposal or has been transported away from the facility for treatment or storage in another facility or that has been cleared;
3. waste that at the turn of the year is present at the facility, the nuclide inventory of the waste and information on its position; and
4. experiences from the handling of the waste and a follow-up of the plans established.

Discharges to air and water from a facility to the surrounding environment is regulated in SSMFS 2008:23 (see section F.4.1.2).

As presented in section E.2.2.3, regulations concerning clearance of nuclear and non-nuclear waste have been issued in the form of SSMFS 2011:2 and SSMFS 2010:2, respectively.

H.1.1.3 Criticality and removal of residual heat

See section G.1.1.3.

H.1.1.4 Interdependencies in waste management and minimisation of radioactive waste

The fact that the licence holders are responsible for the handling and disposal of the radioactive waste they generate provides an incentive to consider all steps from waste generation to disposal. Detailed requirements are stipulated in SSM's regulations:

- An up-to-date inventory of all radioactive waste on-site shall be available at all times (SSMFS 2008:1).
- Measures for the safe on-site handling, storage or disposal of waste shall be analysed and included in the safety report of the facility. The measures for on-site handling shall take into account the requirements on safety posed by the continued handling, transport and disposal of the waste. The safety report shall also include measures that need to be taken on-site to prepare for the safe transportation, storage or disposal in a nuclear waste facility (SSMFS 2008:1).
- Plans shall be drawn up providing a general description of management, including disposal, of all waste types that are likely to be generated while operating the facility. The plan for management of nuclear material shall also state the measures being taken to limit the quantity of nuclear waste and its content of radioactive substances. The plans shall be reported to the authorities before the waste is generated (SSMFS 2008:1).
- As regards waste whose type or quantity deviates from that specified in the plans as stipulated above, all necessary measures for management of the non-conforming material shall be explained and documented in a separate plan. The separate plan shall be reported to the authorities before the waste is handled (SSMFS 2008:1).
- Acceptance criteria shall be derived, stating the properties of the material that can be received for storage, disposal or some other management. Acceptance criteria shall, to the extent that is feasible and possible, be formulated while taking into account safety and radiation protection throughout all stages of the ongoing management. Procedures must be in place for management of material that does not meet the acceptance criteria in that it is returned to the consignor or by taking measures to rectify identified deviations (SSMFS 2008:1).
- The possibility that the limitation of discharges to the environment may imply that radiation doses to the personnel will be increased shall be taken into account during such optimisation, as well as the consequences of other waste management (SSMFS 2008:23).
- Human health and the environment shall be protected from detrimental effects of ionising radiation during the time when various stages of the final management of spent nuclear fuel or nuclear waste are being implemented as well as in the future (SSMFS 2008:37).

H.1.1.5 Protection of individuals, society and the environment

See section G.1.1.5.

H.1.1.6 Biological, chemical and other hazards

General information
Biological, chemical and other hazards will be addressed in the licensing process of an activity. Any such risks that might be associated with the activity should be reported in the EIA. The EIA should also include a description of the measures envisaged to prevent, reduce or remedy adverse effects. During operation the operator is required to continuously take protection measures, make restrictions and take precautions in order to prevent or hinder the activity from causing damage or harm to human health or the environment from chemical, biological and other hazards as well as from a radiological point of view.

Supervision of chemical and biological hazards is primarily exercised by the county administrative board.

Chemical and biological hazards in the context of radioactive waste management
As stated in H.1.1.2, SSM requires updated registers to be kept for all waste and spent nuclear fuel at a nuclear facility. The registers shall for every waste item (e.g. package or component) include information on, among other things, the treatment and the physical and chemical form of the waste. For existing facilities, SKB keeps and manages a register of chemical products stored and used for maintenance and operation.

The question of chemical and biological hazards with regard to the long-term performance of a repository is addressed in the Swedish Radiation Safety Authority's regulations concerning safety in connection with the disposal of nuclear material and nuclear waste (SSMFS 2008:21).

Only packages approved by SSM may be transported to a repository. For this approval, the waste must comply with the conditions stated in the safety report of the repository. Furthermore, the licensee must submit documentation showing that due regard has been taken to all relevant aspects, including biological, chemical and other hazards with regard to the long-term performance of the repository.

H.1.1.7 Striving to avoid actions imposing impacts on future generations

See section G.1.1.7.

H.1.1.8 Aiming to avoid imposing burdens on future generations

See section G.1.1.8.

H.1.2 Measures taken by the licence holders

H.1.2.1 The general obligations of licence holders

Cost calculations
See section G.1.2.1.

RD&D Programme 2013
In the RD&D programme 2013, SKB presents its plans for research, development

and demonstration during the period 2014–2019. The programme consists of five parts:

Part I	SKB's activities and plan of action
Part II	Low and intermediate level waste
Part III	Spent nuclear fuel
Part IV	Research for assessment of long-term safety
Part V	Social science research

Part II in the RD&D programme 2013 covers both current and planned management and disposal of low and intermediate level waste. The programme deals with the following parts:

a) Extension of the final repository for short-lived radioactive waste (SFR)
b) Repository for long-lived waste (SFL)
c) Near-surface repositories
d) Technology development for final disposal of low and intermediate level waste
e) Decommissioning of nuclear facilities

In the above-mentioned work, experience from the operation of SFR constitutes an important knowledge base for the development and construction of new repositories.

In this report measures taken by the licensees regarding general safety requirements are discussed in sections H.3.2, H.4.2, H.5.2 and H.6.2.

H.1.3 Regulatory control

H.1.3.1 The general obligations of licence holders

Nuclear waste fees and guarantees
See section G.1.3.1.

Evaluation of the RD&D Programme
SKB submitted in September 2013 the nuclear reactor owner's tenth updated research and development programme since 1986, RD&D programme 2013, to the regulatory authority, SSM, for review and broad consultation with stakeholders. SSM submitted the results of its evaluation and a statement to the Government in March 2014, approving of the programme.

The overall conclusion from the regulatory review as regards radioactive waste management is that the programme was deemed appropriate for its purpose. The evaluation of the programme was however restrained as to not anticipate eventual conclusions of the upcoming review of the licence applications for an extension of the repository for short-lived low and intermediate level waste (SFR) to also accommodate decommissioning waste.

The main conclusions that SSM drew from the regulatory review with regard to the safety of radioactive waste management were:

- The programme is a step forward in developing and implementing solutions for decommissioning and the disposal of nuclear waste in a manner which complies with the requirements on safety and radiation protection. Still, there

are continued long-term research and development needs in the management and disposal of nuclear waste and decommissioning of nuclear power plants.
- The reactor licensees have submitted updated decommissioning plans for all nuclear power reactors as a consequence of updated and stricter formal regulatory requirements on decommissioning plans. SKB has, in close cooperation with the nuclear power reactor operators, developed and improved the assessments of different categories of waste expected to be generated during decommissioning. This work should be further developed and accounted for in RD&D programme 2016.
- SKB and the reactor owners need to continue consulting with the regulatory body with regard to the expected reporting on decommissioning in RD&D programme 2016.
- SKB has made progress in order to establish a disposal facility for long-lived low and intermediate level waste. A plan with clear milestones, see sections H.4.2, H.4.3 and H.5.2, has been developed and the implementation of the plan will be closely monitored by the regulatory body, especially as regards development of waste acceptance criteria.

H.1.3.2 Basic provisions and licence obligations

Regulatory control of measures taken by the licensees regarding general safety requirements is discussed in sections H.3.3, H.4.3, H.5.3 and H.6.3.

H.1.4 Conclusion

Sweden complies with the obligations of Article 11.

H.2 Article 12: EXISTING FACILITIES AND PAST PRACTICES

Each Contracting Party shall in due course take the appropriate steps to review:

(i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary,

all reasonably practicable improvements are made to upgrade the safety of such a facility;

(ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

H.2.1 Regulatory requirements

H.2.1.1 Existing facilities

By the time the Joint Convention entered into force for Sweden, the situation as regards safety of radioactive waste management facilities was satisfactory. The elements of the Joint Convention have for a long time now been implemented as requirements in the legal and regulatory framework and implemented in the management of radioactive waste. The fact that the licensees' activities are in conformance with the legal and regulatory requirements is something that constantly needs reaffirming through inspection and review activities.

H.2.1.2 Past practices

As described in sections A.5.5.3 and E.2.2.7, a special fee is levied on the nuclear power utilities in accordance with a special enactment, the Studsvik Act, to cover expenses for managing nuclear waste from old experimental facilities, in particular the facilities at Studsvik, the Ågesta reactor and the uranium mine in Ranstad. The special fee is the same for all four nuclear power utilities, currently SEK 0.003 per kilowatt-hour, and it is reassessed annually based on a proposal by the regulatory authority.

H.2.2 Measures taken by the licence holders

H.2.2.2 Past practices

The four utilities operating nuclear power reactors in Sweden (Sydkraft, Vattenfall, Forsmark and OKG) formed a special company in 1992, AB SVAFO, to deal with their responsibilities according to the Studsvik Act, see section E2.2.6. During the period May 2003-March 2009, AB SVAFO was owned by Studsvik Nuclear AB. Its ownership has since then returned to the nuclear power producers in Sweden. AB SVAFO deals with most of the past practices of nuclear waste. These activities

are closely monitored by SSM.

According to estimates, SEK 1.7 billion (equivalent to approx. 156 million euro) will be needed up to the year 2049 to meet the expenses for these activities.

H.2.3 Conclusion

Sweden complies with the obligations of Article 12.

H.3 Article 13: SITING OF PROPOSED FACILITIES

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility
(v) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;
(vi) to evaluate the likely safety impact of such a facility on individuals, society and the environment;
(vii) to make information on the safety of such a facility available to members of the public;
(viii) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.
2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.

H.3.1 Regulatory requirements

H.3.1.1 Assessment of safety and environmental impact

See section G.3.1.1.

H.3.1.2 Public information and involvement

See section G.3.1.2.

H.3.1.3 Consulting contracting parties

See section G.3.1.3.

H.3.2 Measures taken by the licence holders

H.3.2.1 General information

See section G.3.2.

H.3.2.2 Consultations and environmental impact statement

Extension of the final repository for short-lived radioactive waste (SFR)
SKB will apply for an extension of the existing facility for short-lived radioactive waste, SFR, in Forsmark. The alternative site that SKB has chosen to present is the Simpevarp area, outside Oskarshamn. SKB's conclusion is that both sites offer potentially favourable conditions for the long-term safety. The difference between the two sites is largest regarding technical feasibility. From a comparison of

establishment and operation aspects, it is, according to SKB, clear that Forsmark has significant advantages. Basically, this depends on the fact that all short-lived radioactive waste is to be disposed of at one site.

SKB began the consultations for the extension of the final repository for short-lived radioactive waste with an initial consultation with the county administrative board in Uppsala County, Östhammar Municipality and SSM. After the initial consultation, consultations have been held for the relevant authorities and organisations and the public on two occasions: in 2011 and 2012. A final consultation was held in February 2014. Consultation meetings have thus been held at various stages of project planning and design.

The consultation in 2011 focused on an overview of the existing SFR facility, waste and site conditions, and environmental impacts of existing operations as well as tentatively expected environmental impact from the planned extension. The consultation in 2012 focused on the siting work. Furthermore, a general description was given of the current design of the proposed facility and the modernisation and technological development that is investigated for the repository. A preliminary structure for the EIS structure was presented. The consultation in 2014 is focusing on the analysis of long-term safety, the environmental impact statement and a description of the final design of the facility.

Repository for long-lived low and intermediate level waste (SFL)
The last facility that will be built in the LILW programme is the repository for long-lived low and intermediate level waste, SFL. A decision on the siting of this facility will be made in a couple of decades at the earliest. The development of the repository concept is presented in SKB's RD&D programme and successively reviewed by SSM every third year.

H.3.3 Regulatory control

SKB is currently working on a licence application for the extension of the SFR facility. As part of this process, SKB has had to consult with stakeholders according to the rules of the Environmental Code (SFS 1998:808). SSM has, as a regulatory authority, given comments within this consultation process. In addition to this consultation process, SKB has also directly consulted SSM, which as a regulatory authority is obliged by the Administrative Procedure Act (SFS 1986:233) to provide information, guidance, advice and similar assistance to all persons concerning matters falling within the scope of its functions.

H.3.4 Conclusion

Sweden complies with the obligations of Article 13.

H.4 Article 14: DESIGN AND CONSTRUCTION OF FACILITIES

Each Contracting Party shall take the appropriate steps to ensure that:
(i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;
(ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than a disposal facility are taken into account;
(iii) at the design stage, technical provisions for the closure of a disposal facility are prepared;
(iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.

H.4.1 Regulatory requirements

As a result of the review of the industry's R&D programme, it was decided by the Government that a consultation was needed between SSM and SKB regarding the development of the design of a facility for long-lived waste.

See section G.4.1.

H.4.1.1 Suitable measures to limit radiological impact

See section G.4.1.1.

H.4.1.2 Conceptual plans and provisions for decommissioning

See section G.4.1.2.

H.4.1.3 Technology provisions for closure of repositories

See section G.4.1.3.

H.4.1.4 Technology supported by experience

See section G.4.1.4.

H.4.2 Measures by the licence holders

H.4.2.1 Suitable measures to limit radiological impact

The safety philosophy applied in the design of all Swedish nuclear facilities is based on the principles of defence in depth and of multiple barriers to prevent the release of radioactive material to the environment. They are all designed to fulfil the intention of the requirements in the General Design Criteria. The foundation of the safety principle on the defence in depth is emphasized and made clearer

through the implementation of that principle in the general regulations concerning safety in nuclear installations (SSMFS 2008:1).

H.4.2.2 Conceptual plans and provisions for long-lived operational waste, decommissioning and decommissioning waste

A transport cask (ATB 1T) for transport of steel tanks with long-lived low and intermediate level waste is under development. The project is being pursued together with a U.S. supplier, and licensing will be carried out by U.S. regulatory authorities. Validation of this licence will be performed by SSM. SKB has applied for a licence for interim storage of long-lived waste from the nuclear power plants in the extended SFR facility, commencing when the routine operation for the extended facility begins.

An account of different repository concepts for the repository for long-lived waste (SFL), including a qualitative assessment of their long-term safety function, was presented in 2013 and a repository concept for long-lived waste was proposed. The reference inventory has been updated regarding long-lived operational and decommissioning waste from the nuclear power plants.

The conceptual study regarding the SFL repository has essentially followed the methodology used by SKB earlier for system analysis of different solutions for disposal of spent nuclear fuel and has included the following work:

- Identification of strategies for management and disposal of long-lived low and intermediate level waste.
- Identification of different final repository systems or final repository concepts in order to implement a given strategy.
- Identification and choice of selection method and selection criteria.
- Evaluation and choice of repository concepts to work further with.
- Development and improvement of chosen repository concepts.
- Safety assessments and final selection of one repository concept.

SKB has together with the nuclear power companies carried out unit-specific and site-specific decommissioning studies to accumulate a more detailed body of data for estimating waste volumes, material quantities and activity quantities. The results of the studies have served as a basis for designing the capacity of future repositories for decommissioning waste (the extended SFR and the SFL repository).

Decommissioning plans have been developed by SKB as part of the basis for the annual cost calculations. SSM has stipulated a new format and needed input for a decommissioning plan in SSMFS 2008:1.

H.4.2.3 Technology provisions for closure of repositories

Spent Nuclear Fuel Repository

The plan for the closure of the spent nuclear fuel repository has been reported as one of the “production line” reports submitted as reference material to the application in 2011. The need for future developments and tests has been evaluated and has essentially been reported on during 2013 regarding system design and the function of buffer, backfill and plugs. The concrete parts of the plugs in the spent nuclear fuel repository will be made of low-pH concrete instead of conventional

concrete in order to avoid the possible negative effects of basic materials on the properties of the bentonite clay.

A full-scale test of a new plug design has been installed in the Äspö HRL during 2013 and the test will run over at least a three year period, see Figure H1.

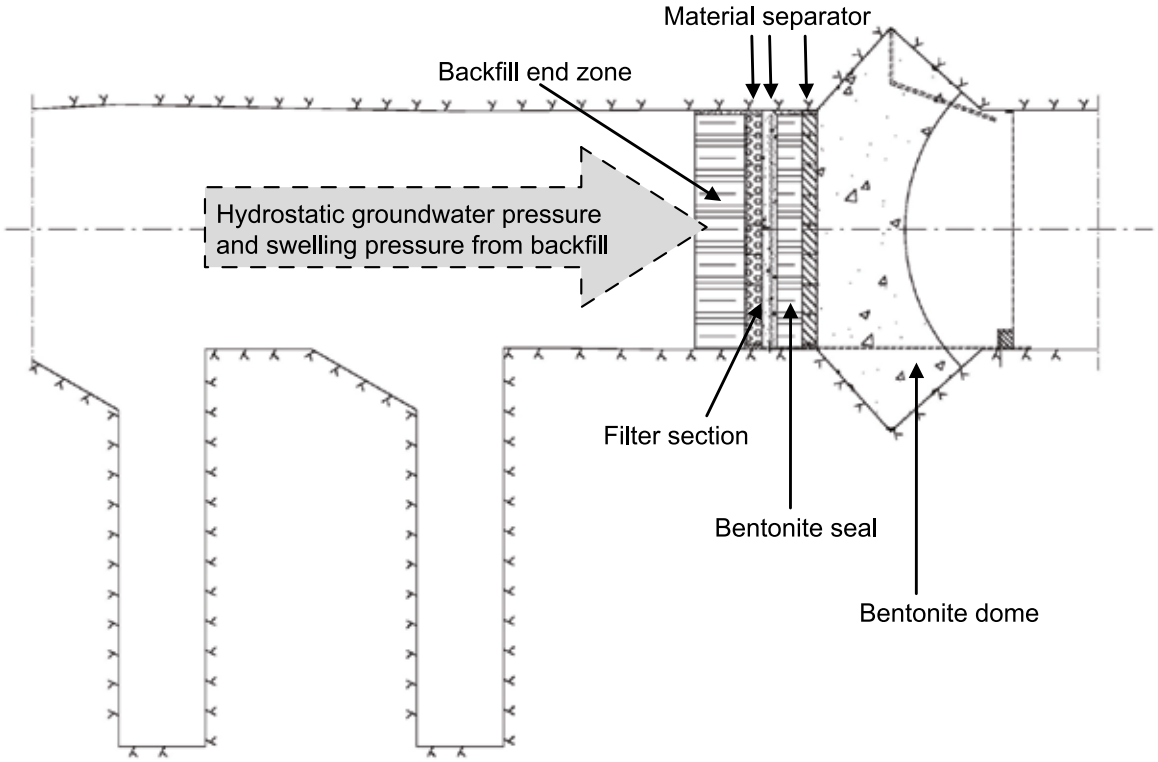

Figure H1: Reference design of dome-shaped plug for a deposition tunnel. The concrete dome is made of unreinforced low-pH concrete.

SFR

When operation of SFR is concluded and measures included in the decommissioning plan have been carried out, all parts of the underground facility shall be closed and sealed. This entails filling the underground facility with material whose purpose is to reduce the mobility of the radionuclides and prevent access to the waste. Closure entails backfilling of rock vaults, installation of plugs consisting of mechanical plugs and hydraulically tight sections, and backfilling of access ramps and the tunnel system. The different parts of SFR will be backfilled in different ways and with different materials to achieve the desired overall function.

Natural materials that are mechanically and chemically stable over a long period of time will be used for the closure components.

The process of closure is assumed to be carried out during a relatively short span of time, where the rock vaults that are being filled with waste will remain open until the entire SFR has been closed. The closure rate is dependent on water flows and pressure distribution, which means that more in-depth studies

of these parameters will be conducted. Developing a strategy for closure of SFR is an ongoing project that will continue.

Since the publication of RD&D programme 2010, SKB has worked with a conceptual closure strategy for an extended SFR. Figure H2 below shows an example of how the closure can be designed. The design of the closure will be described in a closure plan that will be included in the application under the Act on Nuclear Activities for a licence to extend SFR.

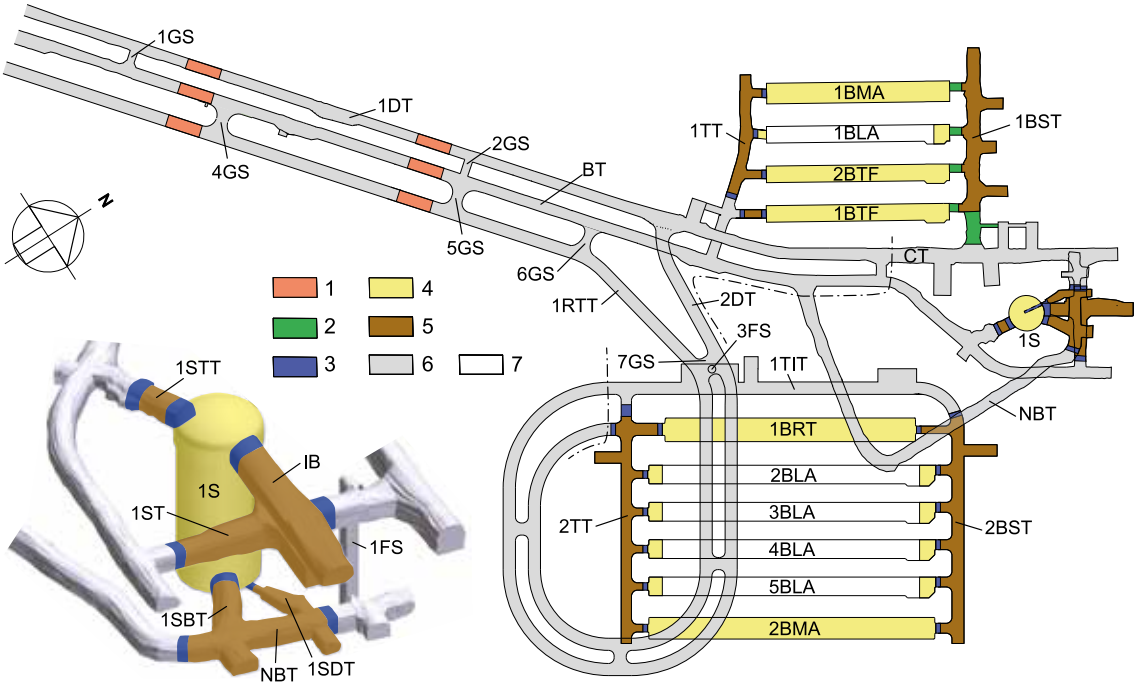

Figure H2: Reference design for closure of SFR including extended part with detailed view of silo. 1) Plugs in access ramps. 2) Transition material. 3) Mechanical plug of concrete. 4) Backfill material of macadam. 5) Hydraulically tight section of bentonite or bentonite mixture. 6) Backfill material in access ramps and tunnel system. 7) Non-backfilled openings.

Plugs will be installed in the connection between the rock vaults and the adjoining tunnels. All plugs are made of two main components: mechanical plugs and hydraulically tight sections consisting of bentonite clay. The purpose of the plugs is to reduce the water flow through the rock vaults. When bentonite clay expands on water saturation, a constraint is needed to maintain its density and low hydraulic conductivity. The mechanical plug can consist of either concrete or transition material that conveys the swelling pressure from the tight section to backfill material in the adjoining tunnel system. The latter solution is called an earth dam plug.

SKB is planning for continued technology development of concrete plugs to achieve a robust design that does not require extensive rock works. One alternative that will be studied is to use concrete plugs where friction against the rock wall

absorbs the load. When the final layout of the extension has been determined, a more precise calculation of the dimensions of each concrete plug may be required.

SKB intends to develop the concept of the earth dam plug and the transition material. The evolution of the earth dam plug over time needs to be studied and analysed. The work that needs to be done mainly involves calculations, parameter studies and modelling.

A more detailed analysis of how the bentonite in the tight sections will be designed and installed needs to be performed. The possibility of achieving sufficiently high density in the hydraulically tight sections with bentonite pellets or granulated bentonite will be studied.

H.4.2.4 Technology supported by experience

General information

The principle of proven technology is broadly accepted and implemented in the design and construction procedures for Swedish nuclear facilities. The use of properly environmentally qualified equipment ensures functioning of safety related systems and components under emergency conditions.

A comprehensive programme for environmental qualification has been carried out. Research and development are continuing. In the modernisation work, the specification of all new installations is carefully checked with respect to environmental requirements.

H.4.3 Regulatory control

Consultations have been held between SSM and SKB regarding the development of the design of a facility for long-lived waste, and a concept study of such a facility was presented by SKB in 2013. Acceptance criteria for long-lived waste, which will be based on the analysis of the chosen concept facility, still need to be developed and will probably be presented by SKB in 2017.

Consultations have been held between SSM and SKB regarding the licence application for the extension of the facility for short-lived waste.

H.4.4 Conclusion

Sweden complies with the obligations of Article 14.

H.5 Article 15: ASSESSMENT OF SAFETY OF FACILITIES

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

(i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

(ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;

(iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in paragraph (i).

H.5.1 Regulatory requirements

H.5.1.1 Assessment of safety

See section G.5.1.1.

H.5.2 Measures taken by the licence holders

5.2.1 Short-lived operational and decommissioning waste

Following the review of the updated safety analysis report conducted by the former Swedish Radiation Protection Authority (SSI) and former Swedish Nuclear Power Inspectorate (SKI), an updated long term safety assessment of the SFR repository was submitted in 2008. As a result of the review by the authority, a more detailed assessment of SFR was submitted in March 2014, especially addressing the long term performance of the rock vault for intermediate level waste (BMA).

A periodic safety review (PSR) should be compiled by the licence holder of the facility every tenth year as described in Section 10a of the Act on Nuclear Activities (1984:3). After a review by the former authority, SKI, the PSR was complemented in 2009. Furthermore, after the former authorities had merged, SSM asked for further complementary information with regards to radiation protection issues. These parts of the PSR were submitted in 2010.

SKB is planning to file an application according to the Act (1984:3) on Nuclear Activities for an extension of the SFR repository. A government licence is required to extend SFR. In the application, SKB will present the technical supporting material, including an environmental impact assessment, that is required to determine whether the existing and extended facility meets the requirements under

the Act (1984:3) on Nuclear Activities and Radiation Protection Act (1988:220). A licensing preliminary safety analysis report (L-PSAR) of operational safety and post-closure safety will be included in the application. SKB will also apply for a permit from the Land and Environmental Court under the Environmental Code for the entire SFR facility.

A process is also ongoing for the extension of the SFR facility according to the Planning and Building Act (2010:900). The main issues in this process are to establish new access to the tunnel to the underground facility and to fill up a water area in order to establish new surface areas for the industrial conditions. A new detailed plan according to the Planning and Building Act is a prerequisite in order to obtain permission for the applied industrial activities.

The licensing preliminary safety analysis report (L-PSAR) will then be updated and further detailed so it can be submitted for approval by SSM prior to the construction of the facility. An updated safety analysis report that is meant to reflect the as-built facility will be prepared prior to trial operation. For SFR, this means that the safety analysis report for present SFR will at this point be replaced by the updated safety analysis report describing trial operation of the extended facility. Before the extended facility may then be put into routine operation, the safety analysis report must be supplemented with experience gained from trial operation. This means that the content of the safety analysis report will change over time. The licensing preliminary safety analysis report (L-PSAR) contains general and conceptual information, which is subsequently made more precise so that it can show in detail before trial operation how the requirements on the facility and its activities have been satisfied. In all phases, the safety analysis report must be approved by SSM.

5.2.2 Long-lived operational and decommissioning waste

As mentioned in section H.4.2.2, an account of different repository concepts for the repository for long-lived waste (SFL), including a qualitative assessment of their long-term safety function, was presented in 2013 and a repository concept for long-lived waste was proposed. The reference inventory has been updated regarding the long-lived operational and decommissioning waste from the nuclear power plants. Together with results of other research and development activities, the proposed concept and the updated reference inventory will serve as a basis for the assessment of the long-term safety of SFL planned for 2016.

Based on the results of the assessment of long-term safety that is planned for 2016, preliminary requirements can be imposed on the site for the SFL repository, and preliminary waste acceptance criteria for the long-lived operational and decommissioning waste can be set. The continued research and safety assessment work will probably lead to modifications of these requirements before they are used to evaluate a candidate repository site.

SKB has together with the nuclear power companies carried out unit-specific and site-specific decommissioning studies to accumulate a more detailed body of data for estimating waste volumes, material quantities, activity quantities and decommissioning costs for the nuclear power plants. The results of the studies have also served as a basis for the safety assessment required in the licensing process of the extended SFR facility, and as a basis for the updated reference inventory for long-lived waste from the nuclear power plants.

H.5.3 Regulatory control

H.5.3.1 Review of the periodic safety report for SFR

Early on in the present review process of the PSR for the SFR repository for low and intermediate level short-lived operational waste that was submitted in 2009 and supplemented in 2010, it was decided that the review would only address the complementary parts of the PSR. In its review SSM concluded that even with the complementary parts, the PSR is still not complete. There is a need for additional information such as the effects of the prolonged operational time on maintenance and operation of the facility and instructions and planning in the area of radiation protection of workers. When the review was finalised, SSM decided not to ask for further complementary information regarding the PSR because the remaining issues are expected to be addressed in SKB's planned application for an expansion of the facility. In its decision, SSM indicated that if the remaining issues are not properly addressed in the licence application, or if a licence application is not submitted at all, SSM will need to reconsider its decision not to ask for complementary information regarding the PSR.

The updated safety assessment of the existing facility, that was submitted in March 2014, will be reviewed as a part of the expected licence application.

H.5.3.2 Review plan for the review of the extension of SFR

In preparation for SKB's forthcoming licence application for the extension of the SFR facility, SSM has drafted a review plan comprising the relevant aspects of SSM's regulatory review of the application. The application will include aspects relating to many different scientific and technical disciplines. In order to thoroughly review all pertinent issues, SSM will enhance its competence base by consulting external experts in a number of fields. SSM is therefore in the process of procuring consultant services following the rules of the Public Procurement Act (2007:1091).

H.5.4 Conclusion

Sweden complies with the obligations of Article 15.

H.6 Article 16: OPERATION OF FACILITIES

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

(i) the licence to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15, are defined and revised as necessary;

(iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures. For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for the period after closure;

(iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;

(v) procedures for characterisation and segregation of radioactive waste are applied;

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

(vii) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

(viii) decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;

(ix) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

H.6.1 Regulatory requirements

See section G.6.1.

H.6.1.1 Initial authorisation

See section G.6.1.1.

H.6.1.2 Operational limits and conditions

See section G.6.1.2.

H.6.1.3 Established procedures

See section G.6.1.3.

H.6.1.4 Engineering and technical support

See section G.6.1.4.

H.6.1.5 Procedure for characterisation and segregation of waste

All waste to be disposed of in SFR, which is described in detail in section D.1.4.4, must conform to predefined waste acceptance criteria. The characteristics of each waste type are documented in a Waste Type Description (WTD). The WTDs are prepared by the waste producer in close contact with the licence holder of SFR (SKB). The completed WTD is submitted to SSM for approval. SSM reviews the WTD and may issue specific conditions for the disposal of a particular waste type. To ensure consistent and comparable WTDs, guidelines have been issued for the structure and content of the WTDs. Waste to be disposed of in shallow land burial facilities are specified and described in the licences, see section D.1.4.5. The licensee must notify SSM at least 3 months in advance of each such disposal campaign and must then provide information about each waste package.

H.6.1.6 Reporting of incidents in a timely manner

See section G.6.1.5.

H.6.1.7 Programmes for collecting and analysing operating experience

See section G.6.1.6.

H.6.1.8 Decommissioning plans

See section G.6.1.7.

H.6.1.9 Closure of disposal facilities

SSM's regulations contain several requirements concerning safety and radiation protection after closure, see sections G.3.1 and G.4.1. There are, however, no specific requirements concerning the closure of repositories for spent nuclear fuel or radioactive waste. For the existing repository for short-lived low and intermediate level operational waste, the SFR facility, requirements regarding closure are instead issued as a licence condition. According to this licence condition, SKB is required to have a developed plan for the future closure of the facility. The requirement is important as the future closure might put different restrictions on the operation of the facility, such as the mechanical performance, physical dimensions or chemical characteristics of the waste and the waste containers. The closure plan might be modified as long as all relevant requirements are still met.

H.6.2 Measures taken by the licence holders

No radioactive waste management facility has been commissioned since 1988, when the repository for radioactive operational waste (SFR) was licensed for operation. As described in the introduction, two additional facilities need to be constructed and taken into operation: a repository for short-lived low and interme-

diate level decommissioning waste, and a repository for the disposal of long-lived low and intermediate level waste.

The general regulations concerning safety in nuclear installations (SSMFS 2008:1) contain legally binding requirements relevant for all obligations of Article 9. These requirements are summarised in section G.6.2.

H.6.2.1 Initial authorisation

According to the current plans, SKB is to submit a licence application for a disposal facility for short-lived low and intermediate level decommissioning waste in 2014, and operation is planned to commence in 2023. The repository is planned to be an extension to the existing repository for radioactive operational waste (SFR). An expansion of this facility to accommodate short-lived decommissioning waste was foreseen in conjunction with planning and licensing and is still judged to be the best solution for this waste.

Also according to the current plans, the repository for long-lived low and intermediate level waste will be sited in around the year 2027 and foreseen to be in operation around 2045. The origin of this waste is primarily research, industry, medical applications, core components and certain internal components from nuclear power reactors. The waste is currently stored at Studsvik, at the nuclear power plants, and at Clab. Dry interim storage facilities for long-lived waste are available at most of the nuclear sites.

H.6.2.2 Operational limits and conditions

See section G.6.2.2.

H.6.2.3 Established procedures

See section G.6.2.3.

H.6.2.4 Engineering and technical support

See section G.6.2.4.

H.6.2.5 Procedure for characterisation and segregation of waste

See section G.6.2.5.

H.6.2.6 Incident reporting

See section G.6.2.6.

H.6.2.7 Operating experience analysis and feedback

See section G.6.2.7.

H.6.2.8 Decommissioning plans

As described in section G.6.1.7, the general regulations concerning safety in nuclear installations (SSMFS 2008:1) comprise requirements on the preparation of decommissioning plans for all nuclear facilities. So far, except for the decommissioning plan for the R2 and R2-0 reactors, only generic and general decommissioning plans have been prepared as part of the basis for the nuclear power utilities' cost estimates for dismantling and disposal of spent fuel and radioactive waste, see

sections F.6 and H.4.2.2. SVAFO has finalized and communicated the complete decommissioning plan for the R2 reactors as part of the process of dismantling the plant, which is planned to commence in late 2014 or 2015.

H.6.2.9 Plans for closure of repositories

The closure of repositories will not take place for at least 30-60 years according to the current plans. Closure is thus still part of SKB's RD&D programme and an item for future safety assessments. Planning for closure has been performed for the SFR facility, see section H.4.2.3.

H.6.2.10 Local monitoring around a disposal facility for spent nuclear fuel

A final repository can affect the environment in different ways, both during construction and operation and after closure. The potential impact can be both radiological and non-radiological. The potential radiological impact is evaluated in the safety assessments, whereas it is assumed that the non-radiological impact can take place during construction and operation and is addressed in the EIA process.

Prior to the start of the site investigations, a thorough survey was conducted of which variables in the surface system need to be described in a site investigation for a final repository for spent nuclear fuel. The survey also identified which parameters need to be described with respect to variation in time. This served as a basis for the extensive programme for collection of both abiotic and biotic parameters that was carried out during the site investigations and that has been reported on in connection with the site descriptions. A reduced sampling programme has also continued after the conclusion of the site investigations in 2007.

In the review of SKB's RD&D programmes 2007 and 2010, the Swedish National Council for Nuclear Waste took up issues related to environmental monitoring in several places. Among other things, the importance of studying the variation of the biosphere parameters in time was pointed out. It was also pointed out that it is urgent that the continued research and development work sheds light on the selection of measurable parameters that can provide a picture of conditions in and around the final repository.

SKB plans to continue with the monitoring programme currently in place for Forsmark. If new knowledge from the biosphere programme shows that additional variables or measurement points are needed to support the biosphere modelling or to distinguish natural variation from effects of a future repository, the programme will be expanded accordingly. In order to distinguish natural variations from repository impact, time series from reference areas will also be needed for a number of key parameters. In the detailed characterization programme that will be designed prior to the start of construction of the repository, the need for reference data will therefore also be met. There is consequently a need for an evaluation of the completed investigations and the collected environmental data thus far.

H.6.3 Regulatory control

H.6.3.1 Initial authorisation

See section G.6.3.1.

H.6.3.2 Operational limits and conditions

See section G.6.3.2.

H.6.3.3 Procedures

See section G.6.3.3.

H.6.3.4 Engineering and technical support

See section G.6.3.4.

H.6.3.5 Characterisation and segregation of waste

As described in section H.6.1.5, all waste types must be approved by the regulatory function before disposal. Compliance with regulations is verified by inspections both at the waste producer and the operator of the disposal facility, e.g. SFR or shallow land burial facilities. The inspections for instance cover administrative routines, documentation, equipment and radiological measurements.

H.6.3.6 Incident reporting

See section G.6.3.5.

H.6.3.7 Experience feedback analysis

See section G.6.3.6.

H.6.3.8 Decommissioning plans

See section G.6.3.7.

H.6.3.9 Plans for closure of disposal facilities

The closure of repositories is still an R&D issue and SKB has to date presented preliminary plans for closure. These plans are part of SKB's RD&D programme which is subject to regulatory review every third year. For more information see section H.4.3.2.

H.6.4 Conclusion

Sweden complies with the obligations of Article 16.

H.7 Article 17: INSTITUTIONAL MEASURES AFTER CLOSURE

Each Contracting Party shall take the appropriate steps to ensure that after closure of a disposal facility:
(i) records of the location, design and inventory of that facility required by the regulatory body are preserved;
(ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and
(iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.

H.7.1 Recordkeeping

The regulations on filing at nuclear plants (SSMFS 2008:38) contain requirements on record management, under which specified documents concerning location, design and inventory of waste are required to be kept in archives for over 100 years. Moreover, the general advice to the regulations SSMFS 2008:37, which concern the protection of human health and the environment in connection with the final management of spent nuclear fuel and nuclear waste, state that the implementer should produce a strategy for preservation of information so that measures can be undertaken before closure of the repository. Examples of information that should be taken into consideration include information about the location of the repository, its content of radioactive substances and its design. Relevant records will be transferred to national and regional official archives when facilities are decommissioned or closed. The authority's documents are regularly transferred to national archives as regulated in the Act on Archives (1990:7) and regulations issued by the National Archives of Sweden. This general type of regulatory mechanism has been in place in Sweden since 1618.

H.7.2 Measures taken by the licence holders

Generally, the licence holder organisations are responsible for the development and management of records and they carry out the necessary R&D on these subjects. The RD&D activities performed by SKB as a basis for the design work on repositories are based on the fact that the design is to be such that the safety of a closed repository is not dependent on surveillance or monitoring, but that some institutional controls can be assumed to exist even after closure, for example safeguards.

Monitoring programmes, covering both geoscientific and ecological parameters, were initiated already during the site investigations of the proposed site for the repository for spent fuel and at the SFR site. A similar programme is envisaged for the planned repository for long-lived low and intermediate level waste. With a few exceptions, these programmes have continued after the completion of the

surface-based site investigations and will continue both during the construction and operation of the repositories.

As construction and operation proceeds there will be a need to regularly reassess the selection of monitoring parameters, monitoring objects and measurement frequencies. If judged useful, long term experiments carried out underground to explore impacts on key barrier functions would also not be excluded.

A quality control programme will be developed prior to excavation with the objective of ensuring that the design premises and other requirements on the construction work and on the operations are fulfilled. Safeguards control will be implemented to the degree needed. The control programme with its quality documentation is the basis for assessing whether the construction and operational work conform to the safety related requirements as expressed in stated design premises and requirements on efficiency and quality. The objectives and content of the control programme will be defined prior to the underground construction work, but will evolve and be adjusted in response to experience gained.

Repository closure is a stepwise process from consecutively closing a deposition tunnel to closing one or several deposition areas before the whole repository is closed. Monitoring is planned to continue until all waste has been emplaced and closure of the repository facility is commenced. At closure monitoring systems only accessible from underground will be decommissioned successively. At that time it must be considered to what extent the closure process itself needs to be monitored.

The surface-based monitoring system may in principle operate even after repository closure. The extent of the post-closure monitoring programme will essentially be determined by decisions made at, or shortly before, closure and it is appropriate that any decisions on post-closure monitoring are taken by the decision-maker at the time of closure. If monitoring after closure is considered, the applicable regulations issued by SSM should be considered (SSMFS 2008:21, Section 8):

> *The impact on safety of such measures that are adopted to facilitate the monitoring or retrieval of disposed nuclear material or nuclear waste from the repository, or to make access to the repository difficult, shall be analysed and reported to the authority.*

Furthermore, the recommendation to this paragraph states:

> *The safety report for the facility in accordance with 9§ should show that these measures either have a minor or negligible impact on repository safety, or that the measures result in an improvement of safety, compared with the situation that would arise if the measures were not adopted.*

H.7.3 Institutional control

Requirements for institutional control after closure are not established nor formally decided. The general regulations concerning safety in nuclear installations (SSMFS 2008:1) stipulate that a facility for the disposal of nuclear waste shall be designed so that the barriers provide the required safety without monitoring or maintenance after the disposal facility is closed. This is further specified in the regulations concerning safety in connection with the disposal of nuclear material and nuclear waste (SSMFS 2008:21) in which it is stipulated that safety after closure of a

disposal facility shall be maintained through a system of passive barriers. Also, the regulations on the protection of human health and the environment in connection with the final management of spent nuclear fuel and nuclear waste (SSMFS 2008:37) require that the long-term performance of a disposal facility should not rely on any active measures.

The four shallow land burial facilities for low-level waste (Oskarshamn, Forsmark, Ringhals and Studsvik) are located within the premises of the power plant or industrial facility at that location. Access restrictions for the repositories are therefore maintained through the access restrictions that apply for the entire facility.

In the case of SFR, the relevant authorities have not yet decided what measures for institutional control, either active or passive, will apply to post-closure. However, the basic philosophy is applicable, that high levels of safety and radiological protection of public health and the environment shall be independent of institutional control.

In the case of the four shallow land burial facilities for low-level waste, institutional control is requested for a period of up to 50 years after closure of the disposal facility. It is the task of the owner and operator of the disposal facility to demonstrate how the requirement on institutional control can be maintained over that period. For longer periods of time, it is foreseen that the environmental hazard and risk are principally of a non-radiological nature. Prolonged requirements on institutional control may be issued by county or municipal administrations. The municipalities' detailed development plans are also of importance by providing conditions concerning the use of the land. All nuclear facilities, including shallow land disposal facilities, are within areas where detailed development plans have been established.

Exempt waste may be deposited on municipal disposal sites and will be subject to institutional control as decided by county or municipal authorities.

According to the regulations on the protection of human health and the environment from discharges of radioactive substances from certain nuclear facilities (SSMFS 2008:23), the holder of a licence shall conduct environmental monitoring. All discharges from facilities for the storage or disposal of radioactive waste shall be monitored by nuclide specific measuring programmes.

H.7.4 Intervention measures

As described above, the regulations (SSMFS 2008:1, SSMFS 2008:21) stipulate that a facility for disposal of nuclear waste shall be designed so that safety after closure of a disposal facility is provided by a system of passive barriers. Prior to the disposal facility closure, the final safety assessment must be renewed and approved by the regulatory authority. If the regulatory authority approves the closure of the disposal facility, the licence holder may be relieved from its responsibilities and obligations. Thus, if intervention measures are needed, it will be the responsibility of the State.

H.7.5 Conclusion

Sweden complies with the obligations of Article 17.

I.1 Article 27: TRANSBOUNDARY MOVEMENT

1. Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and relevant binding international instruments.

In so doing:

(i) a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement is authorized and takes place only with the prior notification and consent of the State of destination;

(ii) transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilized;

(iii) a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;

(iv) a Contracting Party which is a State of origin shall authorize a transboundary movement only if it can satisfy itself in accordance with the consent of the State of destination that the requirements of subparagraph (iii) are met prior to transboundary movement;

(v) a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory, if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.

2. A Contracting Party shall not licence the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

3. Nothing in this Convention prejudices or affects:

(i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;

(ii) rights of a Contracting Party to which radioactive waste is exported for processing to return, or provide for the return of, the radioactive waste and other products after treatment to the State of origin;

(iii) the right of a Contracting Party to export its spent fuel for reprocessing;

(iv) rights of a Contracting Party to which spent fuel is exported for reprocessing to return, or provide for the return of, radioactive waste and other products resulting from reprocessing operations to the State of origin.

I.1.1 Regulatory requirements

There are four different enactments that must be considered in order to obtain a complete picture of the Swedish regulatory requirements regarding transboundary movement of spent nuclear fuel and radioactive waste:

- the Radiation Protection Act (1988:293);
- the Act (1984:3) on Nuclear Activities;
- Council Regulation (EC) No 428/2009; and
- the Act (2000:1064) on Control of Export of Dual-use Products and Technical Assistance.

Sweden has implemented Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel in the national legislation, i.e. the Radiation Protection Act and the Act (1984:3) on Nuclear Activities.

In summary, and as specified in the Radiation Protection Act, a licence to export spent nuclear fuel or radioactive waste from Sweden cannot be granted if the destination is:

i. south of latitude 60 degrees south;
ii. a State party to the Fourth ACP-EEC Convention which is not a member of the European Union;
iii. a State that has forbidden the import of spent nuclear fuel or radioactive waste; or
iv. a State that, in the opinion of the responsible Swedish authorities, does not have the technical, legal or administrative resources to manage the spent nuclear fuel or administrative resources to manage the spent nuclear fuel or radioactive waste safely.

If the export involves radioactive waste that is intended for final disposal in an EU Member State or a third country, further restrictions apply as a consequence of the implementation in Swedish legislation of Directive 2011/70/EURATOM establishing a community framework for the responsible and safe management of spent fuel and radioactive waste.

The Swedish Radiation Safety Authority has the jurisdiction to decide on the export of nuclear material and nuclear equipment as defined in the Annex 1, Category 0 of the Council Regulation (EC) No 428/2009 of 5 May 2009. Export cases that are of a principle importance can be decided by the Government. An application for the export of spent fuel of Swedish origin must include an assurance that the material will be returned to Sweden if it cannot be taken care of as planned.

SSM's regulations and general advice on control of nuclear material, etc. (SSMFS 2008:3) contain stringent national requirements in the field of nuclear non-proliferation. They for example establish the procedure for fulfilling the requirement contained in Council Regulation (EC) No 428/2009.

I.1.2 Regulatory control

Sweden follows the administrative procedures set forth in the Directive 2006/117/Euratom in order to ensure that states of destination and states of transit have the opportunity to give their prior consent, and are notified as is stated in the directive.

I.1.3 Experience of transboundary movements

Studsvik Nuclear AB carries out volume reduction of radioactive waste on a commercial basis, by incineration of combustible waste and melting of scrap metal. The activities are to a certain extent based on services to companies abroad, and Studsvik imports radioactive waste and scrap metal for the purpose of volume reduction. The remaining radioactive waste is re-exported to the country of origin. Approximately one hundred transboundary shipments of this kind are carried out each year.

I.1.4 Conclusion

The Swedish party complies with Article 27.

J.1 Article 28: DISUSED SEALED SOURCES

1. Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, re-manufacturing or disposal of disused sealed sources takes place in a safe manner.
2. A Contracting Party shall allow for re-entry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

J.1.1 Regulatory requirements

All handling of disused sealed sources is covered by the Radiation Protection Act (1988:220). According to the Act, anyone who has conducted activities involving sealed sources must ensure the safe management and disposal of the disused sealed sources, including securing financial resources.

The Radiation Protection Act allows the re-entry of disused sealed sources into Sweden for return to Studsvik Nuclear AB.

Detailed requirements on the handling of disused sealed sources are found in the following regulations issued by SSM.

- Regulations on the Control of High Activity Sealed Radioactive Sources (SSMFS 2008:9) stipulate that high activity sources for which no further use is foreseen must be sent either to the supplier, to the manufacturer or to an approved facility for waste management within six months. The holder must notify SSM, which maintains a register.
- Regulations on Radiation Therapy (SSMFS 2008:33) stipulate that in the case of the purchase of radioactive sources, or equipment which contains such sources, a plan shall be drawn up for the future handling of radioactive waste.
- Regulations on Accelerators and Sealed Sources (SSMFS 2008:27) stipulate that the licence holder shall ensure that an up-to-date and documented plan exists for decommissioning of the facility. The plan shall include an analysis of the resources needed to take care of all radioactive substances and radioactive demolition waste in a safe way from a radiation protection point of view.
- Regulations on the Use of Equipment in Industry Containing Sealed Sources or X-Ray Tubes (SSMFS 2008:40) stipulate that equipment containing a radioactive source for which no further use is foreseen shall be sent to a radioactive waste management facility within six months.
- Regulations on Smoke Detectors for Domestic Use Containing Radioactive Sources (SSMFS 2008:47) stipulate that the units are to be collected and sent for dismantling.
- Regulations on Smoke Detectors for Industrial Use Containing Radioactive Sources (SSMFS 2008:44) stipulate that the disused units should be taken care of as radioactive waste and returned to the supplier or manufacturer.
- Regulations on Import, Export and Reporting on Radioactive Substances

(SSMFS 2008:10) stipulate that in order to import or export disused sealed sources, a licence is needed and the import/export must be reported to the competent authorities.

In addition to the regulations, SSM can also issue licence conditions concerning the management of disused sealed sources.

Two ordinances establish producer responsibility for disused sealed sources: the Ordinance on Producer Responsibility for Electrical and Electronic Equipment (2005:209) and the Ordinance on Producer Responsibility for Certain Radioactive Products and Orphan Sources (2007:193). In effect, the licence holder can fulfil the responsibility established in the Radiation Protection Act regarding safe handling and disposal of a disused sealed source by delivering it to a producer (i.e. a Swedish manufacturer or supplier).

J.1.2 Measures taken by the licence holders

The licensee is required to report to SSM when a practice involving sealed sources ceases, when the ownership of a particular sealed source has been transferred to another licensee, and when a disused sealed source is either returned to a manufacturer or supplier, or sent for disposal. Since one of the fundamental principles of the Swedish radioactive waste management system is that radioactive waste generated in Sweden shall be disposed of in Sweden, disused sealed sources that are to be disposed of are sent to the only recognized radioactive waste management facility in Sweden, Studsvik Nuclear AB, for treatment and storage before disposal. Studsvik Nuclear AB receives approximately 250 disused sealed sources on a yearly basis, to which can be added approximately 130,000 disused smoke detectors and a number of radiation sources from already dismantled smoke detectors.

As Studsvik Nuclear AB accepts a disused sealed source for treatment and disposal, the company takes on the ownership of the sealed source. However, Studsvik Nuclear AB is not required to accept disused sealed sources. The company operates on a commercial basis. Hence, problems may arise if the holder of a sealed source cannot afford the cost for the handling at Studsvik, or if Studsvik for some reason does not accept the disused sealed source for treatment. Problems like these could only be associated with past activities where the requirements on the licensee were not as strict as today, and would have to be handled on a case-by-case basis by SSM together with the licensee.

After treatment, the disused sealed sources are stored by Studsvik Nuclear AB, pending disposal in either the disposal facility for short-lived low and intermediate level waste, SFR, or the disposal facility for long-lived low and intermediate level waste, SFL (for radioactive sources that do not meet the acceptance criteria for SFR). During storage, the sources are retrievable.

Orphan sources

Licence holders are required to take all measures necessary so as not to allow for sealed sources to fall outside of regulatory control. On rare occasions, orphan sources are nevertheless found. If the licensee responsible cannot be identified, the State will provide financial resources for the management and disposal of the orphan source. This is made possible through a special governmental funding arrangement that allows SSM to cover the costs, up to a total of 2 million SEK per

year in 2013 and 2014 for the management and final disposal of orphan sources and legacy radioactive waste from past practices.

J.1.3 Regulatory control

SSM plans and performs inspections regularly at research centres, hospitals and non-nuclear industries. On the part of research centres and hospitals, the entire practice is inspected, including the routines for treatment of waste and the facilities where radioactive waste and disused sealed sources are stored. The handling of disused sealed sources and back-end issues in general are usually brought to the attention of SSM in connection with inquiries by licensees on these issues.

J.1.4 Conclusion

Sweden complies with the obligations of Article 28.

K.1 Measures taken to address suggestions and challenges at previous review

Sweden was at the previous review meeting asked to report at the next meeting in particular on the following planned measures to improve safety:

- Licensing of an encapsulation plant and a disposal facility for encapsulated spent fuel.
- Licensing of an extension to the existing disposal facility for short-lived low and intermediate level waste (SFR) to also accommodate decommissioning waste.
- Development of waste acceptance criteria for long-lived waste.
- Safety reassessments (stress tests) of nuclear power reactors and the central interim storage facility for spent fuel (Clab) as a consequence of the Fukushima Daiichi accident.

K.1.1 Review of the licence application for an encapsulation plant and a repository for spent nuclear fuel

After more than 30 years of research and development, SKB submitted on 16 March 2011 a licence application for the construction of an encapsulation plant at Oskarshamn and a repository for spent nuclear fuel at Forsmark. In the autumn of 2012 SSM completed the initial review phase with a first assessment of the quality and completeness of SKB's application and has now moved on to the main review phase with an in-depth review of the identified safety critical issues. SSM's overall conclusion from the initial review phase was that SKB's reporting is sufficiently comprehensive and of sufficient quality to justify a continuation of SSM's review, but a number of technical and scientific review issues requiring complementary information from SKB were identified. So far one round of a national consultation and an international peer review has been completed.

A review statement regarding the completeness of SKB's application was submitted to the Land and Environmental Court in the autumn of 2012 and a large number of review reports by SSM's external experts have been published on SSM's website. According to the current time schedule, SSM should submit review findings to the Swedish Land and Environmental Court during the first half of 2015 for their main hearing. After the hearing has been completed, SSM will provide an updated report with a recommendation for a licensing decision to the Swedish Government in 2016 according to the present review plan. Meeting this time schedule also depends on the capacity of SKB to submit the complementary information that has been requested and on the progress of the parallel review conducted by the Land and Environmental Court. For more information see section G.5.3.2.

K.1.2 Licence application for a disposal facility for short-lived decommissioning waste

SKB has completed the consultation process to site a disposal facility for short-lived low and intermediate level decommissioning waste. The plan is to extend the existing disposal facility for short-lived low and intermediate level waste (SFR) to also accommodate decommissioning waste. SKB plans to submit applications during 2014 under the Act (1984:3) on Nuclear Activities and the Environmental Code and to have the disposal facility in operation in 2023, see sections H.3.2.2, H.3.3 and H.4.2.3.

K.1.3 Development of waste acceptance criteria for long-lived waste

SKB has, together with the nuclear power companies, carried out unit-specific and site-specific decommissioning studies to accumulate a more detailed body of data for estimating waste volumes, material quantities, activity quantities and decommissioning costs for the nuclear power plants. The results of these studies have served as a basis for updating the reference inventory for long-lived operational and decommissioning waste from the nuclear power plants. Consultations have been held between SSM and SKB regarding the development of the design of a disposal facility for long-lived waste, and a concept study of such a facility was presented by SKB in 2013. Acceptance criteria for long-lived waste, to be based on the analysis of the chosen concept facility, are expected to be presented by SKB in 2017. For more information see sections H.4.2.2, H.4.3 and H.5.2.

K.1.4 Effects from the Fukushima accident

K.1.4.1 The interim storage facility for spent nuclear fuel, Clab

As a follow-up to the severe Fukushima Daiichi nuclear power plant accident, SSM decided in May 2011 that all Swedish nuclear power plants as well as the interim storage facility for spent nuclear fuel (Clab) should be analysed due to requirements specified by the European Nuclear Safety Regulators Group, ENSREG. The aim was to assess the robustness of the facility beyond design basis. The stress test analysis specifications covered five topics to be addressed:

- earthquakes,
- flooding,
- consequences of loss of safety functions:
  1. loss of electrical power (including station blackout),
  2. loss of the ultimate heat sink,
  3. combination of both of the above,
- severe accident management issues, and
- extreme weather.

SKB's stress test analysis of Clab indicated that the facility is robust and able to withstand the events it is designed for, as well as having adequate margins in many of the extreme situations analysed. The analysis, however, identified areas for improvement regarding the facility's resistance and ability to withstand some of the extreme events. SSM's review of SKB's stress test analysis in particular identified the need for further earthquake analysis and analyses on the consequences of loss of water coverage of the fuel.

In April 2012, SSM required all licensees to present action plans for dealing with the deficiencies identified during the stress tests and in September 2012 the licensees submitted their respective action plans. The planned provisions for improvements at Clab included preparing for:

- the instalment of mobile, flexible emergency equipment for power and water supply,
- investigating the need for diesel secured drainage pumps in case of flooding,
- investigating the need for a feed water system also for pools above ground,
- limiting the possibility to isolate fuel with high thermal effect in an individual pool in the receiving hall,

- instructions for the inspection of the facility after an earthquake,
- routines for managing internal and external flooding, and
- measures for the mitigation of extreme weather conditions.

A national action plan covering the nuclear power plants was submitted to ENSREG in December 2012 with the purpose of implementing lessons learned from the accident by managing all plant weaknesses identified by the EU stress tests. The measures listed in the national action plan are scheduled in three different categories, 2013, 2014 and 2015, corresponding to the year when the measures shall be completed. This categorization is based on an assessment of the urgency of the measures' implementation as well as the complexities of these measures.

Not being a part of the national action plan submitted to ENSREG, the Clab action plan and implementation of identified safety enhancements are followed up continuously through SSM's ordinary supervisory activities.

K.1.4.2 Spent fuel pools at NPPs

As a result of the stress test assessments, some areas of improvement for the spent fuel pools in Swedish NPPs have been identified by the licensees and the regulator. The most important actions identified in the Swedish action plan for the spent fuel pools are:

- Seismic analyses: a return frequency of 10^{-5}/year shall be used as a basis for reviews/backfitting of the fuel pools' structural integrity.
- Loss of electrical power, different situations and the impact on the NPPs' spent fuel pools due to loss of electrical power.
- Prolonged extreme situations should be the basis for technical and administrative measures to ensure the capabilities for spent fuel pool cooling during prolonged extreme situations, including alternative means of cooling and residual heat removal of the spent fuel pool.
- Instrumentation: ensure instrumentation for measurement of necessary parameters (water level, temperature) in the spent fuel storage during extreme situations.

The above actions are now being implemented by the licensees.

K.2 Strong features, areas for improvement and major challenges identified by the Contracting Party

K.2.1 Strong features

Clear division of roles and responsibilities

The division of responsibilities is clear in the regulatory framework, with an effective separation between the functions of the regulatory body and the nuclear energy industry.

The nuclear facilities' licensees have the prime responsibility for the safe operation of their facilities and transports as well as the safe disposal of spent fuel and radioactive waste. Swedish nuclear power plant licensees also have a common obligation for the research and development of disposal solutions and for carrying out cost calculations as a basis for payments to the Swedish Nuclear Waste Fund.

The legislation provides the regulatory authority with a strong mandate as well as extensive supervisory and enforcement powers. As a regulator, SSM is authorized to issue legally binding requirements regarding all aspects of nuclear activities and radiation protection. SSM supervises SKB, the power plant operators and other licensees of nuclear activities in fulfilling their responsibilities for safe operation of facilities and transports as well as in planning for decommissioning and disposal.

Continuity in the waste management programme
Building confidence in the safety of spent nuclear fuel and radioactive waste management strongly benefits from a national system with consistent long term strategies and planning. In Sweden, the financial arrangements are in place and have been working for nearly 30 years now; also, a research and development programme on waste management and disposal has been continuously ongoing for more than 30 years.

In addition, the long term strategies are being implemented. The Clab and SFR storage and disposal facilities, respectively, have been in operation since the 1980s. The applications for a spent fuel repository and an encapsulation plant have been under review since 2011 and an application for the extension of the SFR facility to accommodate decommissioning waste is expected in 2014.

Provisions for stakeholder involvement
The ongoing licensing of a spent fuel repository has benefited from the provisions for a transparent and predictable siting and licensing process, with an active involvement of stakeholders. Key contributing features include:

- the nuclear industry's shared obligation for the development of waste management and disposal solutions, manifested in the tri-annual RD&D programmes with associated regulatory reviews, public consultations and Government decisions,
- the local communities' voluntary participation in the siting process and right to veto a Government licensing decision,
- the Environmental Impact Statement that a prospective licensee is required to submit according to the Environmental Code, containing a plan for the formal process of consultation with stakeholders, and
- the financial support to stakeholders through the Nuclear Waste Fund that has made it possible for local communities and environmental organisations to build the capacity to take an active part in formal consultations.

Several stakeholders, both local communities and environmental organisations, have been involved for a long time, are well informed and have built a good capacity for dialogue with the authorities and the implementer. In practice, the provisions for stakeholder involvement have been very beneficial to the overall quality and public acceptance of the licensing process for a spent fuel repository.

The Swedish approach to building trust in the high level waste management system as well as the integrity of the regulator was credited as a Good Practice in the 2011 IAEA IRRS review.

Regulatory involvement in the pre-licensing phase
Through the mandatory review of SKB's and the nuclear power plant owner's

RD&D programmes and cost estimate reports, SSM and the former regulatory authorities have been able to supervise the development of management and disposal solutions in the pre-licensing process since the 1980s. The authorities have followed SKB's siting process, performed pilot safety assessments, taken part in pre-licensing consultations, participated in international projects and carried out independent research on geological disposal. A strong knowledge base has successively been developed, especially on the post-closure safety assessments for geological disposal. As a result, SSM was well prepared when SKB submitted its licence application in 2011 for a spent fuel repository.

In addition to the regulatory involvement and tri-annual strategic Government decisions on SKB's RD&D programme, the pre-licensing review process has also included the possibilities for broad and long-term public participation in the development of a Swedish management system for spent fuel and radioactive waste.

Step-wise licensing process

A key element in the regulatory framework is the clearly defined step-wise licensing process. A licence application for the construction, possession and operation of a nuclear facility is reviewed by the regulatory authority, SSM, and the Land and Environmental Court, and decided on by the Government. Following Government approval, SSM, as part of a step-wise process, authorizes the start of construction, the start of trial operation, the start of routine operation, and the eventual decommissioning of the facility. A Government decision is again needed for de-licensing and exemption from responsibilities. The Authority reviews the application to ensure that all obligations and licensing conditions have been fulfilled.

Openness and transparency

Swedish official documents are public[17] and no one needs to justify a wish to view a public document or to reveal his or her identity to gain access to a document. All SKB report series (except for work documents in progress) are public and can be downloaded from SKB's website, www.skb.se.

SSM provides information services to the public concerning its regulatory activities and regularly publishes reports to inform interested parties and stakeholders. The SSM website is used to provide information on current events and Authority decisions.

Competent regulatory authority

SSM is the national regulatory body with responsibility in the area of nuclear safety, radiation protection and nuclear non-proliferation. SSM is provided with the adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

SSM has an integrated and process-based management system that is certified in the areas of environment, quality management and occupational health and safety. Compared with many other authorities, the staff of SSM has a rather high educational level. This is a result of the many specialist areas covered by the Authority, and to some extent the fact that there are no Technical Support Organisations in Sweden to support the regulatory body with specialist knowledge.

[17] This applies unless a decision has been made to classify them under the Public Access to Information and Secrecy Act (SFS 2009:400). The reasons for secrecy might include interests of national security, international relations, commercial relations, or individuals' right to privacy.

Therefore, SSM supports basic and applied research to maintain and develop the competence of importance for radiation protection and nuclear safety work, and to ensure that SSM has the knowledge and tools needed to carry out effective regulatory and supervisory activities.

Independence of the regulatory authority
The independence of the regulator is stated in Swedish legislation, but it is also a matter of public service culture and values. As a strong, independent and fully accountable national authority, SSM is also confident and trustworthy in upholding high safety standards. The integrity of the regulator has become increasingly crucial with the progression of the licensing review of SKB's application for a spent fuel repository. Strict internal rules apply to the interaction with the applicant and independence from the nuclear industry. All employees and contracted experts have been screened to ensure that they have not been associated with SKB-related activities.

K.2.2 Challenges

Regulations for new nuclear power reactors
Current regulations, waste management systems and plans are based on existing nuclear power reactors. Following the application submitted by the Vattenfall power company to replace one or two reactors, SSM launched the development of regulations to apply to new nuclear power reactors; the regulations also need to address the impact on safe management of spent nuclear fuel and radioactive waste. This work involves analysing how potential new types of reactors and their operation may influence the amount and characteristics of spent fuel and radioactive waste generated in the future.

Managing stakeholder interactions in the licensing review
SSM has promoted transparency and broad stakeholder involvement in the licensing review of the spent nuclear fuel repository. This includes publishing interim results of the licensing review on SSM's website, two rounds of national consultation of SKB's licence applications and public meetings in connection with review milestones. Although these measures are key to the credibility of the licensing review, it is a challenge to simultaneously manage this stakeholder interaction in parallel with the scientific and technical review.

During the siting of the spent nuclear fuel repository, SKB received about 2,000 questions at the consultation meetings performed. In general, the stakeholders have focused on different areas:

- Nearby residents: Traffic, noise, groundwater lowering.
- Municipalities: Infrastructure, local environment issues, pre- and post-closure safety.
- Environmental organisations: Choice of site and method, long-term safety.
- Regulatory authorities: Environmental impact, long-term safety, criteria for site selection, opportunities for and effects of retrieval of canisters.
- Neighbouring countries: Transboundary environmental impact via air and water in connection with regular operation and accidents.

For the implementer, SKB, it is a challenge to maintain the positive prevailing attitude among people in the municipalities of Östhammar and Oskarshamn, which today is in the order of about 80% of the populations based on yearly opinion polls initiated by SKB.

Resolution of controversial scientific issues
Because the spent fuel repository programme lies in the forefront of research and technical development, the ongoing licensing review involves the resolution of difficult and sometimes scientifically controversial issues, for example related to the long-term performance of the engineered barriers of SKB's proposed disposal method. Although the applicant, SKB, is fully responsible for providing sufficient arguments for safety critical issues, the judgement of some of these issues presents a major challenge. To meet these review challenges, SSM requests complementary information from SKB and consults with qualified international experts, see section G.5.3.

Moving from an R&D phase to a licensing phase
The transition in the Swedish waste management programme from an R&D phase to a licensing phase has put a great deal of demands on SKB's organisation, which has grown considerably over recent years. Another type of demand will also have to be met when entering the implementation phase in 2-3 years, pending approval by the authorities and a Government licensing decision. SKB will then have substantial ongoing construction work, which will put high demands on both procurement and project management skills regarding large infrastructural projects.

The transition to a licensing phase also puts new demands on SSM in that there is a need to arrive at more definite conclusions on review issues and compliance evaluation. There is also a need to make a more precise interpretation of the requirements in SSM's regulations. These challenges have been addressed in the ongoing licensing review of the spent nuclear fuel repository by setting up fora for discussion of the application of legal requirements and regulations. SSM also must prepare for a transition from science to engineering skills and competences needed for the step-wise review and authorization of the implementation phase of a spent fuel repository, pending approval by the authorities and a Government licensing decision.

Resources for reviews
The licensing review for an encapsulation plant and a spent fuel repository is a challenge to SSM as a small regulator with limited resources. The staff participating from SSM number 40-50 people drawn from the entire organisation and have a core group of about 10-15 experts. Nearly 40 external experts have been contracted, mostly international researchers and consultants. SSM is currently also preparing for the review of an application from SKB in 2014 for an extension of the SFR facility to accommodate decommissioning waste. An expected, more detailed application from the power company Vattenfall in the next few years for the construction of one or two new reactors will also require competences in waste management. The preparations for the latter include a major oversight of the Authority's regulatory framework with regard to all nuclear activities. In addition, resources need to be available for the Authority's 2016 RD&D programme review,

periodic safety analysis reviews as well as for an increase in decommissioning reviews and authorizations. At the same time, SSM must maintain its high inspection standards in the continuous regulatory supervision of fuel cycle facilities in operation.

SSM is today provided with the necessary competences and financial and human resources needed to fulfil its responsibilities. Maintaining a high quality licensing and supervisory capability very much depends on the continued future access to human resources and competence on both the national and international levels. Therefore, efforts must continue to strengthen training and research, to transfer skills and experiences and facilitate generational shifts, and to build competence in nuclear safety and waste management.

Managing a step-wise licensing process

Although there is a broad international consensus on the merits of a step-wise process for a repository programme, it leads to some questions regarding the information that is sufficient for different licensing steps. Because the current licensing step for the spent nuclear fuel repository is based on information from surface-based site investigations and all of the technical repository solutions have not yet been fully demonstrated, there is remaining uncertainty concerning both repository implementation and long-term safety. SSM will need to decide whether such uncertainty is of a nature that can jeopardize the overall safety objectives of a KBS-3 repository at the Forsmark site, or if it can be dealt with in later stages of the SKB programme through licence conditions or future RD&D programmes.

The fact that Sweden has not previously made a decision-in-principle concerning waste management option and site selection, the current licensing review of the spent fuel repository covers a broad review context. Also, it has proved to be a challenge to deal with the wide array of review issues, ranging from scientifically detailed issues associated with the proposed KBS-3 method to general issues such as justification of the selection of site and disposal method.

The industrialisation of the processes needed to operate a spent fuel repository system is a challenge, which in the coming years will require extensive development efforts from SKB. In addition, the relatively long time horizon covered by SKB's planning means that the planning premises may change in the meantime. SKB must be able to deal with such changes.

K.2.3 Areas for improvement

Regulatory framework

In connection with the 2012 IRRS review of Sweden's compliance with IAEA standards, see section A.7.4.2, SSM was recommended to develop a consistent and more comprehensive set of regulations and general advice.

A major revision of SSM's regulatory framework was initiated in 2012, based on both the IAEA recommendations and SSM's own application experience from the need to clarify and supplement its regulations in order to create more predictability for licensees and to improve the regulatory support for SSM in its supervisory activities. In addition, SSM has been commissioned by the Swedish Government to prepare new regulations in order to develop well adapted and updated requirements for new nuclear power reactors.

Regulatory supervision practices

The IAEA IRRS review team also established that SSM's inspection activities largely focus on licensee management systems and their use in practice by interviewing personnel at different levels of the facilities' organisations and in different functions. SSM was recommended to consider observing activities and performing technical inspections more frequently, as well as to perform a greater number of unannounced compliance inspections.

SSM also needs to develop more specific guidance on how to pursue work on various review and inspection tasks. These processes and written routines should also be communicated to applicants, licensees and other interested parties. The preparation of guidelines is now an important part of the development of new and revised regulations. A risk-based approach to long term strategic planning on SSM's supervisory activities is under development as well.

SSM was also recommended to consider introducing formal competence requirements and compulsory training programmes. A compulsory training programme for all personnel with supervisory tasks has been initiated and is now operational.

Knowledge management and maintaining staff experience

The very long timescales associated with a repository programme requires a good strategy for maintaining review competence. Although SSM has prepared for the licensing of a spent nuclear fuel repository for decades, it has not been possible to fully take advantage of these preparations due to staff turnover. SSM has compensated for this problem by procuring international experts in the review process, including an international peer review. Nevertheless, knowledge management and systematic transfer of staff experience to newly employed staff comprise an area of improvement.

Recommendations from the IRRS team that were directed towards the Swedish Government included measures to maintain national competence in the fields of nuclear safety and radiation protection and to increase SSM's resources for regulatory supervision and licensing reviews.

Legislative oversight

Another recommendation from the IRRS review team that was directed towards the Swedish Government was to establish an ongoing process for keeping the legislation up to date. The 2011 proposal on merging the provisions of the Act on Nuclear Activities and the Radiation Protection Act with the Environmental Code as suggested by a Committee of Inquiry and reported on in the previous national report, is still under consideration by the Government.

As described in Section E, an application for a nuclear facility will be reviewed under several laws. Examination under the Act on Nuclear Activities and the Environmental Code essentially refers to the same questions. This inconvenience was highlighted by the Committee. The Committee has submitted draft legislation to the Government in order to remedy this inconvenience, but under the present circumstances it is unclear if the bill will be adopted, see the introduction to section E).

Responsibilities for waste arising from accidents

As explained in section A.4.3, the state has the ultimate responsibility for spent

nuclear fuel and radioactive waste from nuclear activities. However, this responsibility is secondary to the primary responsibilities of a licence holder. In this context it may be mentioned that the regulations governing liability in the event of nuclear accidents are not entirely satisfactory. Under current legislation the licence holder is responsible for emissions and remediation of radioactive materials at the site where the facility is located. Outside the site (off-site) the respective county administrative board in the affected county or counties are responsible for undertaking response and remediation actions. The responsibility for the final disposal of the waste generated off-site in the case of an accident is currently regulated, though there is no complete plan for how or where larger volumes of heavily contaminated liquid and solid waste are to be disposed of or deposited. As a result of the IRRS recommendation as reported on in section F.5.8, this ambiguity needs to be clarified and regulated.

K.3 Implementation of Directive 2011/70/Euratom

The European Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste entered into force on 23 August 2011. In essence, the directive contains four obligations for EU Member States:

- to bring into force the laws, regulations and administrative provisions necessary to comply with the directive before 23 August 2013 and inform the Commission thereof;
- to notify to the European Commission of the content of their national programmes for spent fuel and radioactive waste management and disposal not later than 23 August 2015 and of any significant changes thereafter;
- to submit a report on the implementation of the obligations in the directive for the first time not later than 23 August 2015 and every three years thereafter; and
- to arrange for self-assessments and invite for international peer review at least every ten years.

Sweden has formally informed the European Commission on the implementation of the directive in the Swedish national framework. Nearly all elements in the directive were already in place. Only minor adjustments were needed in the legislation to clarify that export of spent fuel and nuclear waste for disposal in other countries is prohibited unless conditions as specified in the directive are fulfilled.

By an amendment in 2013 in the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452), SSM is required to ensure that a national plan is in place for the management of spent fuel and radioactive waste that corresponds with the content required under Article 12 of the directive.

K.4 National plan for the management of spent nuclear fuel and radioactive waste

The Swedish national plan for the management of all radioactive waste was first published by SSM in 2009. The purpose was to compile an integrated account of all spent nuclear fuel and radioactive waste generated both within and out-

side the nuclear fuel cycle and to identify and propose any improvements to the management of radioactive waste in Sweden. Actions were proposed in order to strengthen the following areas:

- storage and disposal of radioactive waste from the non-nuclear industry,
- management of orphan sources and inadvertently contaminated products,
- clarification of responsibilities in the legislation, and
- preservation of information as regards waste disposal facilities.

The proposed actions have to some extent been implemented. SSM has performed Government initiated investigations into producer responsibility for disused sealed sources and into the detection of radioactive materials at the border. The results of the investigations have been presented to the Government.

SSM has also developed a long-term plan for its ongoing work on organisation of campaigns in order to recover orphan sources from past activities. The plan is based on the state funding available for the cleanup of orphan sources and other legacy waste that is administered by SSM. As part of the ongoing revision of SSM's regulatory framework, requirements on licensees will be strengthened so that they must have plans for managing radioactive waste from the non-nuclear industry.

According to the Government's instructions for SSM, SSM must ensure that the national plan for the management of all radioactive waste is updated on a regular basis. As a consequence of the implementation of the Council Directive 2011/70/Euratom in the Swedish national framework, the plan must from now on contain the statement required under Article 12 of the directive. SSM is currently updating the national plan for the management of all radioactive waste so that it is consistent with the requirements in the directive. Sweden will notify the content of the national plan to the European Commission by 23 August 2015.

Sweden is frequently obliged to submit reports on the status of spent nuclear fuel and radioactive waste management (regulatory framework, inventories, national infrastructure, etc.), not only for the Joint Convention, but to international organisations such as the IAEA, OECD/NEA and the European Commission. These reporting obligations basically require similar input. In parallel with updating of the national plan for the management of all radioactive waste, SSM is also currently establishing a database in order to facilitate the reporting procedures and provide support to SSM's supervisory activities. It is envisaged that the database tool should be appropriately developed to be used for any reporting activities related to nuclear fuel cycle activities as well as non-nuclear activities, including inventories. Ongoing work at SSM is currently focused on defining and developing proper specifications for the tool to be developed, including possible communication with the IAEA-managed database, NEWMDB.

K.5 Plutonium transfers

K.5.1 Plutonium transfer to the US

Following a review statement from the Swedish Radiation Safety Authority, the Swedish Government took the decision in February 2012 to grant AB SVAFO authorisation to export 3.3 kilograms of separated plutonium and approximately 9 kilograms of natural and depleted uranium to the Department of Energy (DoE) in

the United States for disposition. The export was performed within the framework of the Global Threat Reduction Initiative (GTRI), an American non-proliferation programme with the aim of securing and protecting high-risk and vulnerable nuclear and radiological materials. The recipient was the U.S. government through the U.S. Department of Energy.

Most of the material was generated in Sweden, primarily produced from fuel from the Ågesta reactor that was reprocessed in Mol, Belgium in 1969. Studsvik has been the storage site since the 1970s and the plutonium has been under international safeguards through both the IAEA and the European Commission. The material was initially used in research and development work conducted by the Swedish government. Since 1993, AB SVAFO has been in charge of the material under the Act on Nuclear Activities, and was consequently obliged to take the measures needed for the material's safe management and disposal. The Government decision is based on the end-use, that is, continued storage while awaiting future disposition, also that the ownership will rest in the US and that the transfer was made under the Euratom-US agreement on the peaceful uses of nuclear material which guarantees that it may only be used for peaceful purposes.

K.5.2 Plutonium transfer to the UK

In March 2014 the Swedish Radiation Safety Authority submitted a review statement to the Swedish Government suggesting approval of the application from the Swedish nuclear power company OKG AB to transfer its ownership of 834 kg of separated plutonium to the United Kingdom Nuclear Decommissioning Authority, NDA. The material, which is presently stored in the Sellafield facility, is to be managed together with existing UK plutonium for future use in UK reactors, in line with UK policies. In a June 2014 decision, the Government approved OKG AB's application.

The main part of the plutonium, 833 kg, comes from the reprocessing of 140 tonnes of spent fuel from the Oskarshamn nuclear power plant that was sent to Sellafield between 1975 and 1982. The remaining 1.2 kg of plutonium originates from 4.8 tonnes of spent fuel from the Swedish R-1 research reactor that was exported to Sellafield in 2007. The R-1 fuel was in metallic form and not considered suitable for the Swedish system developed for the final disposal of spent fuel.

The separated plutonium was to be returned to Sweden as MOX fuel for use in the Oskarshamn 2 and 3 nuclear power reactors. The reprocessing plans have been delayed and, due to recent changes in UK fuel manufacturing capability, OKG AB can no longer expect to receive the fuel within the expected lifetime of its reactors.

K.6 Policy and plans for international peer review missions

International peer reviews give valuable input to the improvement of the national framework and serve as an excellent means of building confidence and trust in the management of radioactive waste and spent fuel. As a Member State of the European Union, Sweden is required to periodically, and at least every 10 years, arrange for self-assessments and invite international peer reviews of its national framework, competent regulatory authority and/or national programme with the aim of ensuring that high safety standards are achieved in the safe management of spent

fuel and radioactive waste. The outcomes shall be reported to the Commission and the other Member States, and may be made available to the public where there is no conflict with security and proprietary information.

It is stated in the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452) that SSM is responsible for making proposals to the Government on the appropriate time for the assessments and international peer reviews that shall be performed at least every ten years according to the European radioactive waste and spent fuel management directive (2009/71/Euratom) and the European nuclear safety directive (2011/70/Euratom), respectively. SSM is also responsible for the reporting of assessments and peer reviews carried out and for, based on the results, proposing the actions needed.

In February 2012, SSM received an international peer review of Sweden's compliance with IAEA standards on nuclear safety and radiation protection in the form of a full scope IRRS (Integrated Regulatory Review Service), as assigned by the Swedish Government. In 2014, an IRRS follow-up was requested of the IAEA. The follow-up is planned for 2016.

Utilities in Sweden are traditionally quite active in international cooperation to enhance nuclear safety by sharing experience, contributing to work on international regulation and guidelines and participating in safety assessments and peer reviews such as e.g. IAEA OSART missions and WANO peer reviews. SKB is since 2011 a member of the World Association of Nuclear Operators (WANO) and actively takes part in WANO programmes. In 2013 SKB received a WANO peer review on its operation of the Clab and SFR facilities. A follow-up is expected in one year.

The nuclear industry and regulatory authorities in Sweden also have a long tradition of subjecting safety analyses on the disposal of spent nuclear fuel to international peer review. In support of regulatory reviews conducted since 1983, SSM and its predecessors have on three occasions arranged for international peer reviews of SKB's preliminary safety analyses of the KBS-3 method for the disposal of spent nuclear fuel. The peer reviews have been requested from OECD's Nuclear Energy Agency (NEA), the US National Academy of Sciences or been organised directly by the then regulatory authority, the Swedish Nuclear Power Inspectorate (SKI). In the 1990s, SKI also commissioned the OECD/NEA to organise international peer reviews of two independent safety assessments carried out by SKI based on SKB's KBS-3 method. Lastly, in 2011, SSM commissioned the OECD/NEA to organise an international peer review of the post-closure safety analysis, SR-Site, supporting SKB's licence application for the spent nuclear fuel repository.

The reports from all peer reviews have been published and are publicly available. The results of the more recent peer reviews were also presented at meetings with stakeholders. The hearing of SKB in connection with the most recent peer review of SR-Site in 2011 was open to stakeholders and was also webcast.

For more information on the scope and results of recent peer reviews carried out in Sweden, see section A.7.4.

K.7 Periodic Safety Reviews

At least once every ten years, a new integrated analysis and assessment of the safety of a nuclear facility shall be performed by the licence holder. The analyses

and assessments, as well as the measures proposed on the basis of these, must be documented and submitted to the regulatory authority, SSM, for review. As of 2010, the requirement regarding Periodic Safety Reviews (PSR) is stated in the Act on Nuclear Activities. The PSR should cover both nuclear safety and radiation protection with the purpose of clarifying how requirements stated in relevant legislation as well as issued in the form of regulations and conditions are met, and are expected to be met, over the following ten year period. SSM conducts a comprehensive review and assessment of the submitted review and its references, and determines whether the necessary conditions exist to operate the facility in a safe manner until the next review; this outcome is documented in a review report.

The requirements regarding the periodic safety reviews have developed over the years and are now quite similar to those recommended in the IAEA safety standards. The first and second cycles of PSRs are completed for all reactors, and also the third cycle on the part of seven reactors. Periodic safety reviews have been performed by SKB for the Clab and SFR facilities. SSM has reviewed the PSR for SFR and is currently reviewing the PSR for Clab, which is coordinated with the licensing review for an encapsulation plant. Planned reviews include the Studsvik facilities in 2015 and 2016, followed by the Westinghouse fuel factory in 2017.

K.8 Actions to enhance openness and transparency in the implementation of the obligations under the Convention

The legal framework for the licensing and supervision of nuclear activities in Sweden also stipulates provisions on transparency, openness and public participation. As an example, the regulatory review of SKB's and the power plant owner's tri-annual RD&D programmes, as well as SKB's and the authorities' consultation with stakeholders on the licence application for a spent fuel repository, provide possibilities for broad public participation in the development of a Swedish management system for spent fuel and radioactive waste. Also, according to the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452), SSM is to ensure that a current national plan is in place for the management of spent fuel and radioactive waste corresponding with the content required under Article 12 of Council Directive 2011/70/Euratom. In the process of developing or amending this plan, SSM should give appropriate representatives of relevant agencies, local authorities, the public and industry an opportunity to comment.

Sweden publishes and makes the National Reports of the Joint Convention publicly available on the Internet. SSM also plans to publish the questions and comments received from other contracting parties, including the responses to the questions. All documentation filed relating to the development of each National Report can be requested from SSM in accordance with the Swedish principle of public access to official records.

LIST OF ABBREVIATIONS

ALARA	As Low As Reasonable Achievable (a principle applied in radiation protection)
ABT 1T	Waste container for transportation of long-lived low and intermediate level waste
ACL	The Central Active Laboratory (Studsvik site)
AFS	The Swedish Work Environment Authority's regulations
AM	Interim storage for low and intermediate level waste (Studsvik site)
AS 1-4	Waste storage facility (Studsvik site)
ASAR	As operated Safety Analysis Report
AT	Storage facility for solid intermediate level waste (Studsvik site)
AU	Storage facility for radioactive waste (Studsvik site)
AV	Swedish Work Environment Authority
BAT	Best Available Technique
BFA	Rock Cavern for Waste (Oskarshamn site)
BKAB	Barsebäck Kraft AB
BLA	Rock vault for concrete tanks (part of the SFR facility)
BMA	Rock vault for intermediate level waste (part of the SFR facility)
BNFL	British Nuclear Fuel Ltd
BSS	Basic Safety Standards
BTF	Rock vault for low level waste (part of the SFR facility)
BWR	Boiling Water Reactor
CHP	Combined Heat and Power
Clab	Centralt Lager för Använt Bränsle (central interim storage facility for spent fuel)
Clink	Integrated central interim storage facility and encapsulation plant
COGEMA	Compagnie Générale des Matières Nucléaires
CONVEX	IAEA Convention Exercises
CTH	Chalmers Tekniska Högskola (Chalmers University of Technology)
DG	Director General
ECURIE	European Community Urgent Radiological Information Exchange
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ENSREG	European Nuclear Safety Regulators Group
EU	European Union
FA	Storage facility (Studsvik site)
FEP	Feature, Event and Process
FKA	Forsmarks Kraftgrupp AB
FR0-A	Treatment facility for radioactive non-nuclear waste (Studsvik site)
GDC	General Design Criteria
HA	Incineration facility (Studsvik site)
HCL	Hot Cell Laboratory (Studsvik site)
HELCOM	The Helsinki Commission
HERCA	Heads of European Radiation Control Authorities
HM	Treatment facility for intermediate level waste (Studsvik site)
HRL	Hard Rock Laboratory
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
ID	Evaporation facility (Studsvik site)
IGD-TP	Implementing Geological Disposal of Radioactive Waste Technology Platform
INES	International Nuclear Event Scale
INEX	OECD/NEA International Nuclear Emergency Exercises
INRA	International Nuclear Regulators' Association

LIST OF ABBREVIATIONS

IRRS	Integrated Regulatory Review Service
ISO	International Standard Organisation
KBM	Swedish Emergency Management Agency
KBS-3	Proposed method for disposal of spent nuclear fuel
KSU	Kärnkraftsäkerhet och utbildning AB (Swedish nuclear training and safety centre)
KTH	Kungliga Tekniska Högskolan (Royal Institute of Technology)
LER	Licensee Event Report
LILW	Low and Intermediate Level Waste
LLW	Low Level Waste
MOX	Mixed oxide fuel
MSB	Swedish Civil Contingencies Agency
MTO	Interaction between Man, Technology and Organisation
NEA	Nuclear Energy Agency within the OECD
NGO	Non-Governmental Organisation
NKS	Nordisk kärnsäkerhetsforskning (Nordic Nuclear Safety Research)
NORM	Naturally Occurring Radioactive Materials
NPP	Nuclear Power Plant (including all nuclear power units at one site)
NR-MEG	Nuclear and Radiological Medical Expert Group
OECD	Organisation for Economic Cooperation and Development
OKG	Oskarshamns Kraftgrupp AB
OLC	Operational Limits and Conditions
OSPAR	Convention for the protection of the marine environment of the north-east Atlantic
PHWR	Pressurised Heavy Water Reactor
PSAR	Preliminary Safety Analysis Report/Preliminary Safety Report
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
QA	Quality Assurance
R&D	Research and Development
R0-A	Treatment facility for radioactive non-nuclear waste (Studsvik site)
RAB	Ringhals AB
RASK	SSM methodology for rapid response inspections
RD&D	Research, Development and Demonstration
RO	Reportable Occurrence
SAKAB	Company managing non-radioactive hazardous waste
SAMÖ-KKÖ	National emergency preparedness exercise in spring 2011
SAR	Safety Analysis Report/Safety Report
SFL	Disposal facility for long-lived low and intermediate level waste
SFR	Disposal facility for short-lived low and intermediate level waste
SFS	Swedish Code of Statutes
SKB	Swedish Nuclear Fuel and Waste Management Company
SKI	Swedish Nuclear Power Inspectorate
SMA	Melting facility (Studsvik site)
SMHI	Swedish Meteorological and Hydrological Institute
SNAB	Studsvik Nuclear AB
SoS	Swedish National Board of Health and Welfare
SOU	State Official Report
SR-Site	The long-term safety assessment for the repository for spent fuel
SRV	Swedish Rescue Services Agency
SSI	Swedish Radiation Protection Authority

LIST OF ABBREVIATIONS

SSM	Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority)
SSMFS	SSM's Regulatory Code
STUK	Finnish Nuclear and Radiation Safety Authority
TS	Tank and silo facility (Studsvik site)
TSO	Technical Support Organisation
UA	Waste storage facility (Studsvik site)
WENRA	Western European Nuclear Regulators' Association
VLLW	Very Low Level Waste
WTD	Waste Type Description

Departementsserien 2014

Kronologisk förteckning

1. Gröna boken
   Riktlinjer för författningsskrivning. SB.
2. Patent- och marknadsdomstol. Ju.
3. Europeisk skyddsorder
   – Samarbete om skydd för hotade och förföljda personer inom EU. Ju.
4. Våldsbejakande extremism i Sverige
   – nuläge och tendenser. Ju.
5. Särskilt ömmande omständigheter. Ju.
6. Gårdstödet 2015–2020
   – förslag till svenskt genomförande. L.
7. Minskat svartarbete i byggbranschen. Fi.
8. Den mörka och okända historien
   Vitbok om övergrepp och kränkningar av romer under 1900-talet. A.
9. En samlad kunskapsstyrning för hälso- och sjukvård och socialtjänst. S.
10. En tydligare beredning av myndighetsföreskrifter. Fi.
11. Sveriges sjätte nationalrapport om klimatförändringar
    I enlighet med Förenta Nationernas ramkonvention om klimatförändringar.
    + Engelsk översättning. M.
12. Ekonomiska effekter av ett längre arbetsliv.
    Långsiktiga ekonomiska effekter av Pensionsåldersutredningens förslag. S.
13. Åtalsförordnande enligt 2 kap. brottsbalken. Ju.
14. Genomförande av brottsofferdirektivet. Ju.
15. Ersättning för höga sjuklönekostnader. S.
16. Framtidsfullmakter. Ju.
17. Samordnat ansvar för vissa familjefrågor. S.
18. Den nya polisorganisationen – några frågor om personuppgiftsbehandling m.m. Ju.
19. Statlig ersättning till barn och unga som insjuknat i narkolepsi efter pandemivaccinering. S.
20. Försvaret av Sverige
    Starkare försvar för en osäker tid. Fö.
21. Ett gemensamt europeiskt järnvägsområde. N.
22. Stärkt konsumentskydd vid försäkringsförmedling. Fi.
23. Datalagring, EU-rätten och svensk rätt. Ju.
24. Ökad endomarbehörighet i tvistemål. Ju.
25. Nya regler om upphandling. Del 1 + 2. S.
26. Avtal om val av domstol – 2005 års Haagkonvention. Ju.
27. Ökat stöd för underhållsreglering. S.
28. Delaktighet och rättssäkerhet vid psykiatrisk tvångsvård. S.
29. Förtydliganden och förenklingar inom det arbetsmarknadspolitiska regelverket. A.
30. Informationsutbyte vid samverkan mot grov organiserad brottslighet. Ju.
31. Nya steg för en effektivare plan- och bygglag. S.
32. Sweden's fifth national report under the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management. M.

Departementsserien 2014

Systematisk förteckning

Arbetsmarknadsdepartementet

Den mörka och okända historien
Vitbok om övergrepp och kränkningar av romer under 1900-talet. [8]

Förtydliganden och förenklingar inom det arbetsmarknadspolitiska regelverket. [29]

Finansdepartementet

Minskat svartarbete i byggbranschen. [7]

En tydligare beredning av myndighetsföreskrifter. [10]

Stärkt konsumentskydd vid försäkringsförmedling. [22]

Försvarsdepartementet

Försvaret av Sverige
Starkare försvar för en osäker tid. [20]

Justitiedepartementet

Patent- och marknadsdomstol. [2]

Europeisk skyddsorder
– Samarbete om skydd för hotade och förföljda personer inom EU. [3]

Våldsbejakande extremism i Sverige.
– nuläge och tendenser. [4]

Särskilt ömmande omständigheter. [5]

Åtalsförordnande enligt 2 kap. brottsbalken. [13]

Genomförande av brottsofferdirektivet. [14]

Framtidsfullmakter. [16]

Den nya polisorganisationen – några frågor om personuppgiftsbehandling m.m. [18]

Datalagring, EU-rätten och svensk rätt. [23]

Ökad endomarbehörighet i tvistemål. [24]

Avtal om val av domstol – 2005 års Haagkonvention. [26]

Informationsutbyte vid samverkan mot grov organiserad brottslighet. [30]

Landsbygdsdepartementet

Gårdsstödet 2015–2020
– förslag till svenskt genomförande. [6]

Miljödepartementet

Sveriges sjätte nationalrapport om klimatförändringar
I enlighet med Förenta Nationernas ramkonvention om klimatförändringar. + Engelsk översättning.[11]

Sweden's fifth national report under the Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management. [32]

Näringsdepartementet

Ett gemensamt europeiskt järnvägsområde. [21]

Socialdepartementet

En samlad kunskapsstyrning för hälso- och sjukvård och socialtjänst. [9]

Ekonomiska effekter av ett längre arbetsliv. Långsiktiga ekonomiska effekter av Pensionsåldersutredningens förslag. [12]

Ersättning för höga sjuklönekostnader. [15]

Samordnat ansvar för vissa familjefrågor. [17]

Statlig ersättning till barn och unga som insjuknat i narkolepsi efter pandemivaccinering. [19]

Nya regler om upphandling. Del 1 + 2. [25]

Ökat stöd för underhållsreglering. [27]

Delaktighet och rättssäkerhet vid psykiatrisk tvångsvård. [28]

Nya steg för en effektivare plan- och bygglag. [31]

Statsrådsberedningen

Gröna boken
Riktlinjer för författningsskrivning. [1]

Fritzes
ett Wolters Kluwer-företag

106 47 Stockholm Tel 08-598 191 90 Fax 08-598 191 91 order.fritzes@nj.se www.fritzes.se

ISBN 978-91-38-24168-4 ISSN 0284-6012