



Strålsäkerhetsmyndigheten

Swedish Radiation Safety Authority

Rapport

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Swedens second National Report on Implementation of Council Directive 2011/70/Euratom



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FOREWORD

Context

This report has been prepared to meet the requirement of Article 14.1 of Council Directive 2011/70/Euratom, establishing a Community Framework for the responsible and safe management of spent fuel and radioactive waste. Article 14.1 requires that Member States shall submit a report to the Commission on the implementation of this Directive for the first time by 23 August 2015, and every three years thereafter, taking advantage of the review and reporting under the Joint Convention. This report provides an account for developments since the previous report issued August 2015.

This report has been prepared by the Swedish Radiation Safety Authority, SSM, as required by the government in the Ordinance with instruction for the Swedish Radiation Safety Authority (2008:452).

Scope

This report addresses the implementation of the obligations of EC Directive 2011/70/Euratom. It focusses on describing how specific measures are taken at the national level that corresponds to specific requirements in the waste directive, using an article-by article approach.

The cut-off date for information in this report is 31st of December 2017, and for inventories 31st December 2016. It should be emphasised that parts of the legal and regulatory framework are currently undergoing extensive updates and improvements, partly due to implementation of new EC legislation but also driven by efforts for continuous improvements of the regulatory framework.

Some overarching considerations

The greater part of waste containing radioactive substances requiring specific measures for its containment and isolation comes from the production of electricity by means of nuclear power reactors. The main driver for implementing necessary infrastructure for managing spent nuclear fuel and nuclear waste is the general obligation on reactor operators to safely manage such material. Institutional radioactive waste may, when required (containment and isolation) and appropriate (compatible with nuclear waste management) be disposed of in disposal facilities for nuclear fuel cycle wastes. It follows that the information in this report focusses on the development and implementation of management solutions for spent fuel and nuclear waste, supplemented with relevant information specific for management of institutional radioactive waste.

Relationship with other relevant reporting internationally

A comprehensive account of national policies, the legal and organisational framework and strategies governing the management of spent fuel and radioactive waste can be found in the Safe and responsible management of spent nuclear fuel and radioactive waste in Sweden, SSM report 2015:32, August 2015 (“National plan”) [1], published in 2015. The plan was notified to the Commission to satisfy the requirement in the European Council Directive 2011/70/Euratom, Articles 13.1 and 15.4, respectively, the responsible management of spent fuel and radioactive waste. The directive requires a national program to be updated with regard to any significant changes. The developments taken



place since the notification of the National plan are described in the main reference documents to the National plan, subject to update every three years, i.e. the RD&D-program 2016 [2] and the Plan report 2016 [3]. The development as accounted for in those reports does however not require an update of the National plan.

Sweden is a Contracting Party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention). Sweden is thus obliged to submit a national report on Sweden's implementation of the obligations of the Joint Convention every three years, as a basis for the Review Meetings under the convention. In order not to duplicate too much of detailed information in the Joint Convention report in the current report, reference is when deemed appropriate made to relevant information in the most recent national report under the Joint Convention [4].

The structure of the report follows the ENSREG guidelines [5].

Section A contains a high-level overview of arrangements for management of spent fuel and radioactive waste. The section includes an overview of current sources for spent fuel and radioactive waste including historical and legacy wastes. In a general sense, it discusses potential future sources for spent fuel and radioactive waste. On a principle level, it also addresses policies governing management of spent fuel and radioactive waste, established activities for management of spent fuel and radioactive waste as well as remaining activities yet to be established.

The purpose with section B is to serve as a major information source on the progress made in the management of spent fuel and radioactive waste by summarising the developments since the previous National Report.

Section C - M addresses in due detail all aspects of the implementation of the waste directive.



LIST OF ABBREVIATIONS

BKAB	Barsebäck Kraft AB (licence holder of Barsebäck NPP)
Clab	Central Interim Storage Facility for Spent Nuclear Fuel
ENSREG	European Nuclear Safety Regulators Group
EIA	Environmental Impact Assessment
ESS	European Spallation Source ERIC
FKA	Forsmark Kraftgrupp AB (licence holder of Forsmark NPP)
IAEA	International Atomic Energy Agency
IRRS	Integrated Regulatory Review Service
ILW	Intermediate level waste
LLW	Low level waste
NPP	Nuclear Power Plant (including all nuclear power units at one site)
OKG	Oskarshamns Kraftgrupp AB (licence holder of Oskarshamn NPP)
OLC	Operational Limits and Conditions
PSR	Periodic Safety Review
RAB	Ringhals AB (licence holder of Ringhals NPP)
RD&D	Research, Development and Demonstration
SAR	Safety Analysis Report
SFL	Disposal facility for long-lived radioactive waste
SFR	Disposal facility for short-lived radioactive waste
SNAB	Studsvik Nuclear AB
SKB	Svensk Kärnbränslehantering AB (the Swedish Nuclear Fuel and Waste Management Company)
SSM	Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority)
SSMFS	Strålsäkerhetsmyndighetens författningssamling (the SSM Code of Statutes)
SVAFO	Swedish company engaged in management of radioactive waste
VLLW	Very low level waste
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulator's Association



A. INTRODUCTION

A.1. Sources of spent fuel and radioactive waste

A.1.1 Current sources for spent fuel and radioactive waste

Spent fuel emanates mainly from eight reactors in operation at three sites; Ringhals (operated by Ringhals AB, RAB). Oskarshamn (operated by Oskarshamns Kraftgrupp AB, OKG, and Forsmark (operated by Forsmark Kraftgrupp AB, FKA). Spent fuel also emanates from two permanently closed down reactors in 1999 and 2005, respectively, at the Barsebäck site (operated by Barsebäck Kraft AB, BKAB), and two reactors at the Oskarshamn site permanently closed down in 2017.

Radioactive waste originates from the nuclear power industry as well as from medical use, industry, research, education and consumer products. In addition, nuclear waste is produced at the Studsvik site (closed research reactor, hot-cell and waste treatment facilities) and at Westinghouse Electric Sweden AB's fuel fabrication plant. Disused sources that are not returned to out of country producers, are sent to Cyclife Sweden AB for treatment and storage prior to disposal.

In total the Swedish nuclear power programme will generate approximately 12 600 tonnes spent fuel, 180 000 m³ short-lived LILW from operation and decommissioning and 16 000 m³ long-lived LILW (based on 60-years operation of currently operating reactors except for reactors Ringhals 1 and 2, planned to be closed down before the end of 2020). The typical total annual production of short-lived LILW at the nuclear facilities is 1 000-1 500 m³. The program will in addition generate approximately 54 000 m³ of VLLW.

The numbers above includes institutional radioactive waste from non-nuclear fuel cycle activities, e.g. roughly 2 500 m³ of long-lived-LILW from the European Spallation Source ERIC (ESS).

Figure A.1 illustrates the geographical location of nuclear facilities where spent fuel and/or radioactive waste is generated, managed or disposed of.

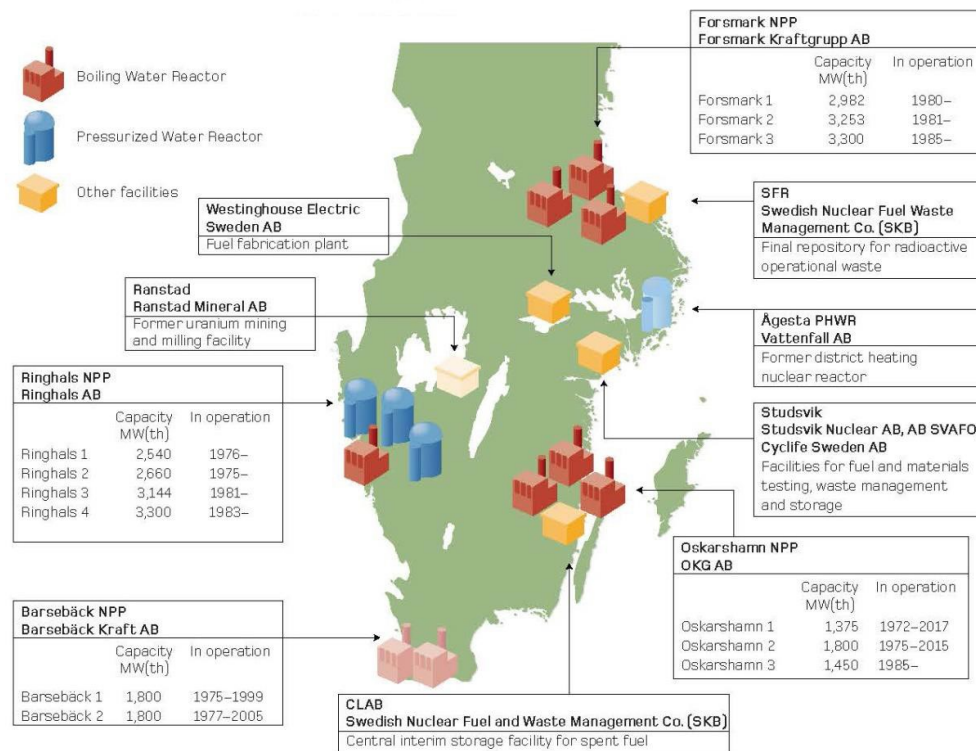


Figure A.1: Nuclear facilities in Sweden

A.1.2. Historical and legacy wastes

Past research activities have also generated some waste, which is either stored awaiting disposal or have already been disposed of. Early activities generating spent fuel and radioactive waste were:

- Operation of the research reactor R1 in Stockholm 1954–1970.
- Research activities at the Studsvik site including operation of research reactors between 1958 and 2005.
- Operation of the Ågesta district heating reactor between 1964 and 1974.
- Uranium mining and milling facilities in Ranstad operated in the 1960's.

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 nuclear power plants were built in the early 1970's, arrangements were made to send the spent nuclear fuel abroad for reprocessing.

140 tonnes of spent fuel was shipped to UK between 1972 and 1982. The reprocessing took place in 1997 and resulted in 136 tonnes of uranium and 833 kilograms of plutonium. Possession of the plutonium was transferred from OKG to the UK Nuclear Decommissioning Authority, NDA, in 2014. The uranium has been shipped to Russia and used to produce new fuel for OKG.

A total of 55 tonnes of spent fuel was also shipped to France for reprocessing in the late 1970's. The fuel was later exchanged for 24 tonnes of used MOX-fuel from Germany. The used MOX-fuel from Germany is now stored in the Clab facility.



Reprocessing of spent fuel is since the early 1980's not included in the Swedish waste management programme.

A.1.3 Potential future sources for spent fuel and radioactive waste

The application received in 2012 from the power company Vattenfall for the replacement of one or two reactors at the existing sites in operation was put on hold by Vattenfall in 2014 due to difficult market conditions with weak demand, a surplus of generation capacity and historically low electricity prices.

However, new reactors (if they were constructed), would imply that the total volumes of spent fuel and nuclear waste will become larger than anticipated within the current program for management and disposal of spent fuel and nuclear waste. Waste inventories in this report addresses only spent fuel and waste from currently existing reactors.

As a consequence of the establishment of the European Spallation Source ERIC (ESS) in the town Lund, additional radioactive waste will have to be managed. Current estimates indicates the need for disposal of 2 500 m³ of long-lived LILW in the planned repository for such waste.

A.2. Implementing organisations and regulatory authorities

A.2.1 The main implementing organisations

The four companies operating nuclear power plants (BKAB, FKA, OKG and RAB) are responsible for the safe management and storage of spent fuel and nuclear waste at the NPP sites, as well as decommissioning of the NPPs and associated facilities at the NPP sites. The NPP companies have joint ownership of the Swedish Nuclear Fuel and Waste Management Co (SKB) which assists them in executing their responsibilities (see section A.3).

Three nuclear licensees, Cyclife Sweden AB, Studsvik Nuclear AB (SNAB) and AB SVAFO, conduct nuclear activities and operate facilities at the Studsvik site, and they are responsible for safe management of spent fuel and radioactive waste from their nuclear activities.

Cyclife Sweden AB (owned by French EDF) manages radioactive waste from medicine, research, industry and education and manages Studsvik's waste treatment facilities. These include the incineration facility (HA) used for incineration or pyrolysis of nuclear as well as non-fuel cycle low-level wastes. The melting facility (SMA) is used for volume reduction of contaminated metal. Disused sealed sources and radioactive waste from medical use, research and industry are mainly managed in the treatment facilities for radioactive non-nuclear waste (FR0-A and R0-A)

Studsvik Nuclear AB (SNAB) provides services in fuel and materials technologies to the nuclear power industry. Testing of materials and reactor fuel is performed in its own laboratories on site. The facilities include the hot cell laboratory (HCL) and the active metal laboratory (AKLAML), primarily used to investigate irradiated nuclear fuel and irradiated metallic materials.



AB SVAFO is jointly owned by the NPP utilities and is responsible for decommissioning of old research and development facilities and for management of legacy waste.

A.2.2 Regulatory authority

The Swedish Radiation Safety Authority (SSM) is the responsible regulatory authority as regards safe management of spent nuclear fuel as well as nuclear and radioactive waste, and mandated to issue regulations on nuclear safety and radiation protection.

A.3. Spent fuel and radioactive waste management overview

The basic provisions forming the basis for management of spent fuel and radioactive waste are prescribed in the legal documents as listed below, and discussed more in detail in Section E.

- The Environmental Code (1988:808)
- The Radiation Protection Act (1988:220)
- The Ordinance (1988:293) on Radiation Protection
- The Act (1984:3) on Nuclear Activities
- The Ordinance (1984:14) on Nuclear Activities
- The Act (2006:647) on Financing of Management of Residual Products from Nuclear Activities
- The Ordinance (2017:1179) on Financing of Management of Residual Products from Nuclear Activities
- The Act (1988:1597) on Financing of Certain Radioactive Waste etc.
- The Ordinance (2007:193) on Producer Liability for certain radioactive products and radioactive sources with no owner.

It should be noted that that parts of the legal and regulatory framework are currently undergoing extensive updates and improvements, as described in section B. Information on the outcome of this process will be provided in the next report under the EC Directive 2011/70/Euratom to be submitted in 2021.

A.3.1 Management organisations

The Swedish legislation clearly points out the holder of a licence to operate a nuclear facility as being primarily responsible for the safe handling and disposal of spent nuclear fuel and nuclear waste, as well as decommissioning and dismantling of the facility. Not until the waste is disposed of in a repository that is finally sealed, can the Government discharge the waste producer from its liability, and the long-term liability will then rest with the State.

The nuclear power plant licensees have joint ownership of the Swedish Nuclear Fuel and Waste Management Co (SKB), which assists them in executing their responsibilities. SKB has been tasked with the responsibility for handling, transportation and storage of spent fuel and radioactive waste outside the nuclear power plants, as well as for disposal of spent nuclear fuel and nuclear waste. This includes the responsibility to carry out necessary research and development activities and the compilation of updated research, development and demonstration (RD&D) programmes every three years. The most recent RD&D- programme was published by SKB and submitted to SSM for review and evaluation in September 2016.



SKB is the licensee and the operator of the central interim storage for spent fuel (Clab) and the disposal facility for short-lived low and intermediate level waste (SFR). SKB also owns and operates M/S Sigrid, a custom-made IMO INF3 class ship, to transport spent fuel and radioactive waste from nuclear power plants to Clab and SFR.

SKB is also tasked with the responsibility to perform the nuclear industries integrated cost estimates for management and disposal of spent fuel and nuclear waste as well as for decommissioning of NPPs and other nuclear facilities.

According to the Radiation Protection Act, all parties that have generated radioactive waste are responsible for the safe management of the waste, including securing of financial resources. This applies to all non-nuclear fuel cycle activities where radioactive material is used. Cyclife is the only organisation in Sweden that offers treatment and storage of institutional waste. As Cyclife accepts to treat waste, subject to a cost, the company also takes on the responsibility for the continued safe management and disposal of the waste. There are no plans to establish specific disposal facilities for institutional radioactive waste. Such waste is either disposed of in SFR, or stored until disposed of in a future disposal facility for long-lived low and intermediate level waste (SFL). The fee to Cyclife Sweden AB includes the cost for this disposal.

A.3.2 Management of spent nuclear fuel and radioactive waste

Figure A.2 illustrates schematically the system for management of spent fuel and radioactive waste as presented in SKB's RD&D-programme 2016. Facilities that remain to be realised are an encapsulation plant for spent fuel and repositories for spent fuel, long-lived low and intermediate level waste, and for decommissioning waste. SKB's RD&D programme is focused on these matters.

Clearance

Material may be cleared for unrestricted use or for disposal as conventional non-radioactive waste according to approved procedures as prescribed in SSM code of statutes.

Very Low Level Waste (VLLW)

The nuclear power plants at Ringhals, Forsmark and Oskarshamn as well as the Studsvik site have shallow land fill facilities for solid short-lived very low-level waste (<300 kBq/kg). Each landfill facility is licensed for a total activity of 100-1100 GBq (with a maximum of 0.1-0.2 GBq of alpha-active substances). At Studsvik, the final disposal campaign was performed in 1999, and the licence to dispose waste expired in 2010.

Short-lived low- and intermediate level waste (LILW-SL)

Radioactive operational waste from nuclear reactors, but also institutional waste are disposed of in SFR.

Waste from decommissioning of the nuclear power plants is also planned to be disposed of in SFR. In December 2014, SKB submitted a license application for an extension of the facility in order to increase the disposal capacity by an estimated 170,000 m³ in total from today's 63 000 m³.

Long-lived low- and intermediate level waste (LILW-LL)

The origin of this waste is primarily from operation and decommissioning of nuclear power reactors as well as from research, industry and medical applications. The waste is currently stored at Studsvik site, the nuclear power plants and Clab or, when appropriate,



in SFR. According to current plans, a license application to build a disposal facility for long-lived low and intermediate level waste (SFL) will be submitted in 2030 and operation is planned to commence in 2045. The volume of SFL will be relatively small compared to SKB's other disposal facilities, and the total disposal volume is estimated to 16 000 m³.

Spent nuclear fuel

Spent nuclear fuel from the nuclear power reactors is temporarily stored on-site in water-filled fuel pools for at least nine months, before being transported to the central interim storage for spent nuclear fuel (Clab), where it will be stored for at least another 30 years before being encapsulated and deposited in a disposal facility.

Legacy wastes

Legacy wastes vary with regards to categorization, measurements accuracy and conditioning. Treatment and conditioning of these wastes have been managed on a case-by-case basis and SSM has opted to have early in-sight in these projects and to handle them, both their regulation and control, on a case-by-case basis. The final waste packages, however, must fit into the available waste streams of the disposal program and, to the extent possible, fulfil the general requirements of the regulations.

Transport system

Transportation of spent nuclear fuel and radioactive waste is mainly by sea, because 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.

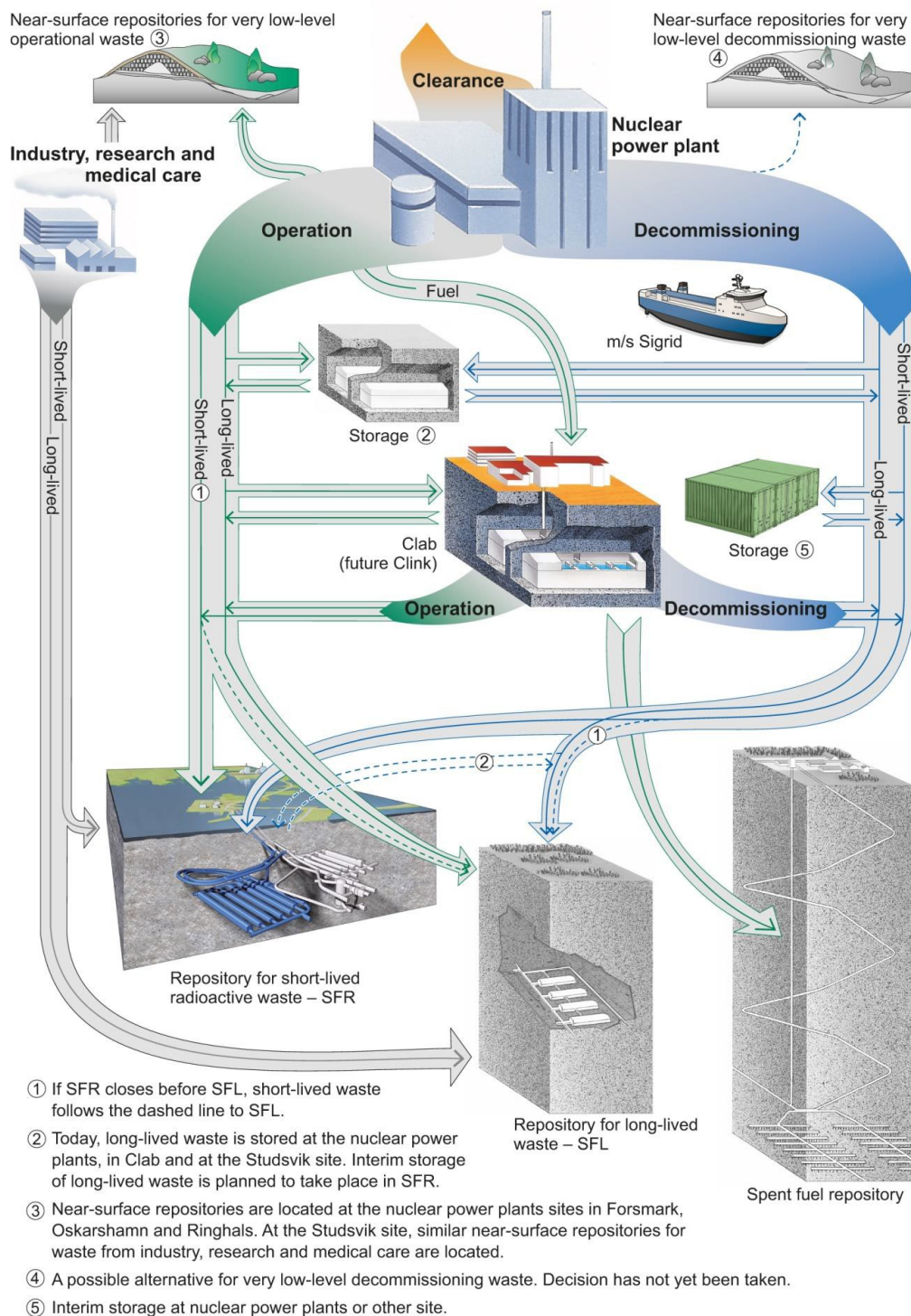


Figure A.2: System for management of spent nuclear fuel and radioactive waste as presented in SKB's RD&D programme 2016.



B. RECENT DEVELOPMENTS

This section briefly summarises key developments in Sweden's waste management programme since the previous National Report. Relevant decisions regarding Sweden's nuclear power programme are also included.

B.1 Application for new nuclear reactors on hold

The application received in 2012 from the power company Vattenfall for the replacement of one or two reactors at the existing sites in operation was put on hold by Vattenfall in 2014 due to difficult market conditions with weak demand, a surplus of generation capacity and historically low electricity prices.

B.2 Nuclear decommissioning

The reactors at the Barsebäck site were permanently closed down in 1997 and 2005, respectively. Decommissioning activities have started after many years of service operation. In 2015 an interim storage facility was established on the site, and in 2016, the dismantling and segmentation of internal reactor parts from unit B2 commenced. The final dismantling work is planned for 2021.

In October 2015 decisions were taken to permanently close down four more commercial reactors. OKG decided to permanently close down the two oldest reactors unit 1 and 2 (both BWR) at the Oskarshamns NPP, in 2017, and RAB decided to permanently close down the two oldest reactors unit 1 (BWR) and 2 (PWR) at the Ringhals NPP, before the end of 2020.

The Ågesta PHWR has been in service operation since 1974. Preparations are now being made for the start of dismantling in 2020.

The dismantling of the materials testing reactor at the Studsvik site (R2) started in February 2015, and is planned to continue until 2019, aiming for free-release of the facility.

The decommissioning of the Ranstad uranium mining and milling facility that started in 2010 is nearing completion. Dismantling of the processing plant took place in 2017 and subsequent radiological controls and preparations for site release is performed.

B.3 New Studsvik licensee – Cyclife Sweden AB

On 1 July 2016, the radioactive waste and materials technology company Studsvik Nuclear AB (SNAB) formed a new subsidiary, Studsvik Nuclear Environmental AB (SNEAB), responsible for Studsvik's waste treatment assets and facilities for metal recycling, incineration and pyrolysis. The new licence and transfer of responsibilities were decided on by the Government in accordance with the Act on Nuclear Activities. The licence applications were reviewed by SSM. SSM also authorised the start of operations. Shortly thereafter, SNEAB was acquired by French EDF and renamed Cyclife Sweden AB, aimed at offering decommissioning and waste management services.



B.4 Licensing review of a spent nuclear fuel repository

In June 2016, SSM submitted a statement to the Land and Environment Court based on the outcome of the Authority's review of SKB's licence applications under the Act on Nuclear Activities. In its statement, SSM concluded that both the proposed encapsulation facility and the geological repository have the potential to comply with radiation safety requirements in compliance with pertinent regulations.

The main hearings of the Land and Environment Court in assessing SKB's licence application under the Environmental Code was conducted in September and October 2017¹.

B.5 Licence application for extension of the SFR disposal facility

In 2014, SSM received a licence application for an extension of SFR so that it can also accommodate decommissioning waste. SSM's review is ongoing and SKB has submitted complementary information upon request by SSM.

B.6 Review of SKB's eleventh RD&D programme

In September 2016, the Swedish Nuclear Fuel and Waste Management Company (SKB) submitted its eleventh tri-annual research, development and demonstration programme (RD&D Programme 2016) to SSM for evaluation and review, including a public consultation process. Based on its review, SSM concluded that RD&D Programme 2016 fulfils statutory requirements. In its statement of March 2017, the Authority recommended that the Government approve the programme's reporting.²

B.7 Financing system related developments

B.7.1 Revisions to the financing legislation

The Act (2006:647) and Ordinance (2017:1179) on Financing of Management of Management of Residual Products from Nuclear Activities has been revised in order to further reduce the state's financial risk. The changes came into force 1 December 2017 and the main significant material changes are;

- broadening the investment opportunities of the Nuclear Waste Fund;
- linking the discount rate curve to the Nuclear Waste Fund's anticipated yield and stipulating the calculation principles in the Act and Ordinance;
- basing the computation of fees on 50 years of operation on the part of nuclear power reactors in operation;
- broadening the guarantee for contingencies in order to cover risks in terms of both assets and liabilities, in addition to their being computed by the state, and
- implementing 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.

¹ Both the Land and Environmental Court and SSM submitted statements with their final recommendations on the applications to the Swedish Government in January 2018.

² The Government decided 21 March 2018 that the RD&D-programme 2016 fulfils statutory requirements.



B.7.2 Audit by the Swedish National Audit Office

The Swedish National Audit Office (NAO) presented in November 2017 the outcome from an audit of the central government financing system for the back-end of the nuclear power program. The main significant recommendations to the Government are;

- to ensure that the total risks for the State can be assessed by assigning one specific agency the formal overall responsibility for analysis and assessment of risks in the financing system;
- to develop reporting to the Riksdag (the Swedish Parliament) of total risks in the financing system, to increase transparency and insight into the system.
- to investigate whether the parent companies instead of the reactor companies should bear the primary payment responsibility.

The NAO in addition recommends SSM and the National Debt Office to make active use of the right to issue regulations and the right to issue risk-limiting conditions as well as other tools to increase transparency in the calculations and reduce the State's risk.

B.7.3 Overview of the Studsvik Act

The Act (1988:1597) on Financing of Certain Radioactive Waste etc (Studsvik Act), for the clean-up of legacy waste from historic nuclear activities, expired at the end of 2017. This means that future disbursements from the Studsvik Fund will be regulated through the Act (2006:647) on Financing of Management of Residual Products from Nuclear Activities (Financing Act). The fees collected in the Studsvik Fund serves as cost contribution for the clean-up activities. If the fund's assets are insufficient to cover future liabilities for facilities that are still in operation, the licensees of these facilities are required to pay the additional fees necessary according to the provisions of the Financing Act.

B.7.4 Review of SKB's estimation of costs of the future programme

SKB submitted in January 2016 updated cost estimates on the future management and disposal of spent nuclear fuel and nuclear waste, and decommissioning and dismantling of nuclear facilities. SSM reviewed the cost estimates and submitted in October 2016 to the Government an evaluation with proposals for fees to be paid to the Nuclear Waste Fund as well as size of guarantees. The Government decided in December 2017 on the fees to be paid per delivered kilowatt-hour of electricity generated for the years 2018 through 2020, as well as the guarantees.

B.7.5 Orphan sources control

For the period 2016 to 2018, SSM received SEK 11 million of extra funding to reinforce safe management of orphan sources in the form of radiation sources from disused smoke detectors that have been incorrectly delivered to recycling centres.

B.8 Implementation of Council Directives under the Euratom Treaty

B.8.1 Council Directive 2013/59/Euratom (BSS)

On 1 July 2016, after consultation with stakeholders, SSM submitted a proposal to the Government for a new act and ordinance on radiation protection for fulfilment of necessary amendments to the legislation owing to Council Directive 2013/59/Euratom



(BSS). Pending Government and Parliament decisions, a review of SSM's regulations is ongoing, with the overall aim of having all legislative changes that apply to the BSS implemented by 6 February 2018.

B.8.2 Council Directive 2014/87/Euratom

The Act on Nuclear Activities has been amended in order to implement the amendments to EC Directive, 2009/71/Euratom, through the implementation of EC Directive 2014/87/Euratom. The changes clarify the licensee's responsibility for safety as well as that safety must be continuously evaluated and verified. Also, new provisions have been introduced in order to give SSM insight into how licensees ensure that contractors and suppliers meet the safety requirements. The amendments entered into force on 1 August 2017.

B.9 Update of legislation

B.9.1 New radiation protection legislation

Due to the implementation of Council Directive 2013/59/Euratom (BSS) the Parliament has decided to replace the previous Act on Radiation protection with a completely new act and associated ordinance³.

B.9.2 Improvements to the nuclear safety legislation

The Government decided in July 2017 to set up a commission of inquiry to review the need for amendments to the Act (1984:3) on Nuclear Activities and the Ordinance (1984:14) on Nuclear Activities and, and if necessary, propose changes to the Radiation Protection Act and necessary consequential changes to the Environmental Code and funding legislation. The main elements to be addressed are e.g.;

- to examine the possibilities and benefits of coordinating the responsibilities under the Act on Nuclear Activities and the Environmental Code,
- to analyse the pros and cons of separating nuclear safety and radiation protection from the post-closure responsibility for nuclear waste disposal,
- to analyse what should be required in the event of a change of license holder and conditions for changes in ownership of reactor companies, and
- propose regulation regarding ultimate responsibility after closure of a disposal facility.

The assignment is to be reported by 1 April 2019.

B.10 Revising and updating regulations

In 2012 SSM initiated a major multi-objective revision of its regulatory framework. The revision addresses IRRS recommendations regarding consistency of the Swedish regulatory framework with IAEA Safety Standards. It takes into account the above-mentioned implementation of the EU directives on nuclear safety, waste management and the BSS, as well as implementing WENRA's applicable safety reference levels. Another important goal of the regulatory revision is to facilitate for licensees to interpret regulatory requirements as well as to improve the regulatory support for SSM in its supervisory

³ The Radiation Protection Act (2018:396) and associated Ordinance (2018:506) on Radiation Protection.



activities. A report on the status of the project will be provided in the next reporting according to Article 14.1 of Council Directive 2011/70/Euratom.

B.11. Maintaining competence at the national level

In December 2016, SSM received a Government assignment to investigate the conditions for maintaining national competence in the Authority's areas of responsibility. The final findings and recommendations on necessary measures to ensure the long-term availability of competencies are to be reported in September 2018.

B.12 European Spallation Source ERIC

SSM decided on 30 June 2017 to grant the European Spallation Source ERIC (ESS) authorisation to begin installation of the ESS research accelerator in Lund. Further authorisations will be required from the Authority before the facility may be commissioned. The ESS application has also been reviewed by the Land and Environment Court under the Environmental Code. On 12 June 2014, the Court gave ESS conditional approval.



C. SCOPE AND INVENTORY (ARTICLE 2, ARTICLE 12.1 (C), ARTICLE 14.2 (B))

Article 2 - Scope

1. *This Directive shall apply to all stages of:*
 - (a) *spent fuel management when the spent fuel results from civilian activities;*
 - (b) *radioactive waste management, from generation to disposal, when the radioactive waste results from civilian activities.*
2. *This Directive shall not apply to:*
 - (a) *waste from extractive industries which may be radioactive and which falls within the scope of Directive 2006/21/EC;*
 - (b) *authorised releases.*
3. *Article 4(4) of this Directive shall not apply to:*
 - (a) *repatriation of disused sealed sources to a supplier or manufacturer;*
 - (b) *shipment of spent fuel of research reactors to a country where research reactor fuels are supplied or manufactured, taking into account applicable international agreements;*
 - (c) *the waste and spent fuel of the existing Krško nuclear power plant, when it concerns shipments between Slovenia and Croatia.*
4. *This Directive shall not affect the right of a Member State or an undertaking in that Member State to return radioactive waste after processing to its country of origin where:*
 - (a) *the radioactive waste is to be shipped to that Member State or undertaking for processing; or*
 - (b) *other material is to be shipped to that Member State or undertaking with the purpose of recovering the radioactive waste.*

This Directive shall not affect the right of a Member State or an undertaking in that Member State to which spent fuel is to be shipped for treatment or reprocessing to return to its country of origin radioactive waste recovered from the treatment or reprocessing operation, or an agreed equivalent.

Article 12 - Content of national programmes

1. *The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:*
 - (...)
 - (c) *an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;*

Article 14 - Reporting

- (...)
2. *On the basis of the Member States' reports, the Commission shall submit to the European Parliament and the Council the following:*
 - (...)
 - (b) *an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects.*



C.1 Scope of application

This report provides an account for implemented and planned national arrangements for management of spent nuclear fuel and nuclear waste as well as for management of institutional radioactive waste.

These arrangements ensure the safe management of i) spent nuclear fuel and nuclear waste from the Swedish nuclear program, including from early research and development activities, ii) from current research and development activities conducted at the Studsvik site, and iii) institutional radioactive waste from medical purposes, industry, agriculture, non-nuclear fuel cycle research activities and education.

This report does not address waste containing only naturally occurring radioactive material, or waste from extractive industries which falls under the Directive 2006/21/EC.

Details on the inventory of spent nuclear fuel and nuclear and radioactive waste to be disposed of in dedicated disposal facilities are provided in Appendix 1.

C.2 Waste categorisation

There is no legally defined waste classification scheme in Sweden for nuclear or radioactive waste. There is, however, an established waste classification scheme that is used by the Swedish nuclear industry. The classification scheme is destination-driven and customized with regards to existing and planned repositories (end points) as presented in in Table C.1.

The waste classification scheme used by the industry can be converted to the scheme used by IAEA (GSG-1) according to the matrix below, Table C.2.



Table C.1: Waste classification scheme used by the nuclear industry.

	Definition	Specific considerations	Destination
Cleared Material	Material with so small amounts of radioactive nuclides that it can be released from regulatory control	-	No final repository needed
Very low level waste, short-lived (VLLW-SL)	Contains small amounts of short lived nuclides with a half-life less than 31 years, dose rate on waste package is less than 0,5 mSv/h. Long lived nuclides with a half-life greater than 31 years can be present in restricted quantities	-	Shallow landfill
Low level waste, short-lived (LLW-SL)	Contains small amounts of short lived nuclides with a half-life less than 31 years, dose rate on waste package (and unshielded waste) is less than 2 mSv/h. Long lived nuclides with a half-life greater than 31 years can be present in restricted quantities.	-	Final repository for short-lived radioactive waste (SFR)
Intermediate level waste, short-lived (ILW-SL)	Contains significant amounts of short lived nuclides with a half-life less than 31 years, dose rate on waste package is less than 500 mSv/h. Long lived nuclides with a half-life greater than 31 years can be present in restricted quantities.	Requires radiation shielding during transport	Final repository for short-lived radioactive waste (SFR)
Low and intermediate longlived, waste (LILW-LL)	Contains significant amounts of long lived nuclides with a half-life greater than 31 years, exceeding the restricted quantities for short lived waste	Requires special containment during transport	Final repository for long-lived radioactive waste (SFL)
Spent fuel/High level waste (HLW)	Typical decay heat $>2\text{kW/m}^3$ and contains significant amounts of long lived nuclides with a half-life than 31 years, exceeding the restricted quantities for short lived waste	Requires cooling and radiation shielding during intermediate storage and transport	Final repository for spent fuel

Table C.2: Comparison between the classification scheme and the IAEA definition.

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



D. GENERAL PRINCIPLES AND POLICIES (ARTICLE 4)

Article 4 – General principles

1. *Member States shall establish and maintain national policies on spent fuel and radioactive waste management. Without prejudice to Article 2(3), each Member State shall have ultimate responsibility for management of the spent fuel and radioactive waste generated in it.*
2. *Where radioactive waste or spent fuel is shipped for processing or reprocessing to a Member State or a third country, the ultimate responsibility for the safe and responsible disposal of those materials, including any waste as a by-product, shall remain with the Member State or third country from which the radioactive material was shipped.*
3. *National policies shall be based on all of the following principles:*
 - (a) *the generation of radioactive waste shall be kept to the minimum which is reasonably practicable, both in terms of activity and volume, by means of appropriate design measures and of operating and decommissioning practices, including the recycling and reuse of materials;*
 - (b) *the interdependencies between all steps in spent fuel and radioactive waste generation and management shall be taken into account;*
 - (c) *spent fuel and radioactive waste shall be safely managed, including in the long term with passive safety features;*
 - (d) *implementation of measures shall follow a graded approach;*
 - (e) *the costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials;*
 - (f) *an evidence-based and documented decision-making process shall be applied with regard to all stages of the management of spent fuel and radioactive waste.*
4. *Radioactive waste shall be disposed of in the Member State in which it was generated, unless at the time of shipment an agreement, taking into account the criteria established by the Commission in accordance with Article 16(2) of Directive 2006/117/Euratom, has entered into force between the Member State concerned and another Member State or a third country to use a disposal facility in one of them. Prior to a shipment to a third country, the exporting Member State shall inform the Commission of the content of any such agreement and take reasonable measures to be assured that:*
 - (a) *the country of destination has concluded an agreement with the Community covering spent fuel and radioactive waste management or is a party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management ('the Joint Convention');*
 - (b) *the country of destination has radioactive waste management and disposal programmes with objectives representing a high level of safety equivalent to those established by this Directive; and*
 - (c) *the disposal facility in the country of destination is authorised for the radioactive waste to be shipped, is operating prior to the shipment, and is managed in accordance with the requirements set down in the radioactive waste management and disposal programme of that country of destination.*

D.1 National policies

D.1 1 Fundamental principles

The rationale for the management of spent fuel and radioactive waste are based on basic principles derived from extensive discussions in the Swedish parliament. The national



policy and strategy for the management system for spent fuel and nuclear waste are based on the following four basic principles⁴:

1. Expenses for the disposal of spent nuclear fuel and nuclear waste are to be covered by revenues from the production of energy that has resulted in these expenses.
2. The reactor owners are to safely dispose of spent nuclear fuel and nuclear waste.
3. The state has the ultimate responsibility for spent nuclear fuel and nuclear waste. The long-term responsibility for handling and disposal of spent nuclear fuel and nuclear waste should rest with the state. After a repository has been closed, a requirement should be established to ensure that some kind of responsibility for and supervision of the repository can be made and maintained for a considerable time. A government authority could assume the responsibility for a closed repository.
4. Each country is to be responsible for spent nuclear fuel and nuclear waste generated in that country. The disposal of spent nuclear fuel and nuclear waste from nuclear activities in a foreign country may not occur in Sweden is not allowed in Sweden other than in an exceptional case.

These are the basic principles for the structure of the Act (1984:3) on Nuclear Activities. They are also contained in the Act (2006:647) on Financing of Management of Residual Products from Nuclear Activities.

D.1.2 Ultimate responsibility

The ultimate responsibility for ensuring the safety of spent fuel and radioactive waste rests with the State, as accounted for above. However, this ultimate responsibility has not been explicitly expressed in the legislation, but through Government statements in terms of it 'is a matter of course' and does not need to be implemented in the legislation.

D.1.3 Minimization of waste arising

Overarching requirements for waste minimization in general are established in Chapter 15 of the Environmental Code (1988:808).

SSM general regulations SSMFS 2008:1 contain specific provisions specifying that nuclear activities shall be carried out so as the amount of nuclear waste and its content of radioactive substances is limited as far as reasonably possible.

D.1.4 Interdependencies between management steps

As accounted for above, the overall responsibility for development of disposal facilities rests with the reactor licensees. To ensure that finally conditioned waste packages are compatible with waste acceptance criteria for the disposal facilities, a system is established where the licensee of the disposal facility is required to develop acceptance criteria which the waste producer must meet, to be allowed to send waste packages for disposal.

⁴ 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).



This system provides for a “cradle-to-grave” management system which ensures that interdependencies between management steps are properly taken into consideration. Acceptance criteria are subject to regulatory approval and is part of the safety analysis report (SAR) for the disposal facility.

D.1.5 Safe management, including in the long term, passive safety features

Basic safety requirements for nuclear activities, including safe and responsible management of spent nuclear fuel and nuclear waste is primarily regulated in Section 10 of the Act (1984:3) on Nuclear Activities. Correspondingly, basic safety requirements for management of radioactive waste from non-nuclear fuel cycle activities is regulated in the Radiation Protection Act (1988:220).

Section 2 of Chapter 6 in SSMFS 2008:1 contains general requirements on the design of spent fuel and nuclear waste facilities to be based on passive safety features as far as possible and reasonable. More specific requirements are found in Section 2 of The Swedish Radiation Safety Authority’s regulations concerning safety in connection with the disposal of nuclear material and nuclear waste (SSMFS 2008:21) where it is explicitly stated that safety after the closure of a repository shall be maintained through a system of passive barriers.

D.1.6 Graded approach

Licensing of nuclear activities under the Act (1984:3) on Nuclear Activities as well as licensing of activities involving radiation under the Radiation Protection Act (1988:220) allows for application of the concept of graded approach, i.e. with due consideration to the scope and nature of the activity at hand. If an activity requires a license under the Environmental Code (1998:808), the code also allows for application of the graded approach.

Implementation of measures can also be adjusted by making exemptions from the requirements in regulations that are not required when considering nuclear or radiation safety (see for example Chapter 16 of the Environmental Code, Section 14 Act on Nuclear Activities and Section 4 of the Ordinance (1988:293) on Radiation Protection. In addition, SSM has the possibility to make exemptions from legislation (see Section 3 Radiation Protection Act and Section 2 a Act on Nuclear Activities).

For nuclear activities, the concept of graded approach is also addressed in the general regulation SSMFS 2008:1. Section 1 of Chapter 2 in SSMFS 2008:1 specifies that radiological accidents shall be prevented through a facility specific and fundamental design. There are also provisions for the application of a graded approach by means of references to a “facility specific” approach as regards construction (Chapter 3, Section 1) and operation (Chapter 3, Section 3) of facilities, as well as for classification of structures, systems and components (Chapter 3, Section 4).

D.1.7 Polluter Pays Principle

The implementation of the fundamental principles as accounted for in D.1.1 in practice constitutes the implementation of the producer pays principle.

Basic requirements related to obligations to cover the costs for management of spent fuel and nuclear waste are found in Section 13 of the Act (1984:3) on Nuclear Activities.



Detailed provisions on the financing obligations are found in the Act (2006:647) and Ordinance (2017:1129) on Financing of Management of Residual Products from Nuclear Activities.

Basic requirements related to institutional radioactive waste are found in Section 13 of the Radiation Protection Act (1988:220), required to ensure the safe management and disposal of the waste, including securing financial resources, and well as in the Ordinance (2007:193) on Producer Liability for certain radioactive products and radioactive sources with no owner.

D.1.8 Evidence-based and documented decision-making processes

Nuclear facilities are licensed under the Act (1984:3) on Nuclear Activities, and the Environmental Code (1998:808). A Governmental decision related to licensing of a nuclear facility include license conditions, authorizing SSM to approve the construction, the trial operation including commissioning, the routine operation and the decommissioning of the facility. Hence, SSM has to approve each stage in the life cycle of the facility. Each decision issued by SSM in this regard is founded on the regulatory review of an application from the licensee, based on an appropriate collection of arguments and evidence (safety demonstration) to justify the decision. Details on the system of licensing are found in section E.2. A corresponding step wise licensing process can also be applied to non-nuclear fuel cycle facilities licensed under the Radiation Protection Act (1988:220), if deemed necessary by SSM.

The Safety Analysis Report (SAR) is central in the overall decision-making process. According to Chapter 4, Section 2 SSMFS 2008:1. The SAR shall 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 shall reflect the facility as built, analysed and verified, as well as show how the requirements on its design, function, organization and activities are met. A preliminary SAR shall be compiled before a facility may be constructed and, for an existing facility, before major refurbishing or rebuilding work or major modifications are carried out. The SAR shall be updated before trial operation of the facility may commence so that the report reflects the facility as built. The SAR shall be supplemented, taking the experience of such trial operation into account, before the facility is subsequently taken into operation. The preliminary SAR as well as the updated and supplemented SAR shall at all stages have been reviewed and approved by the Swedish Radiation Safety Authority. The SAR shall subsequently be kept up-to-date.

D.2 Prerequisites for disposal of spent fuel or waste in other countries

The Radiation Protection Act (1988:220) and the Act (1984:3) on Nuclear Activities contain basic provisions prohibiting export of spent nuclear fuel and nuclear waste for disposal in other Member States or third countries, unless preconditions as specified in Article 4.4 are fulfilled.

Section 20 of the Radiation Protection Act (1988:220) stipulates that a license is required for depositing radioactive substance or a material containing radioactive substances in Sweden. According to Section 20 of the Radiation Protection Act (1988:220) a license is also required for disposing radioactive waste or substance in another country. Section 20 b of the Act regulates the requirements for such a license including an agreement between



Sweden and the other state regulating conditions for the deposit. Further detailed requirements on the agreement and the license are stipulated in the Ordinance (1988:293) on radiation protection, Sections 13 b, 13 c and 13 e.

The Act (1984:3) on Nuclear Activities specifically regulates nuclear facilities and Section 5 a of the Act prohibits disposal of radioactive waste, from a nuclear facility or from a nuclear activity abroad, in a repository in Sweden without a specific licence. Neither can radioactive waste from a nuclear activity in Sweden be disposed of abroad without a specific licence. The requirements for the license are regulated in 5 b of the same Act and include the requirement of an agreement between Sweden and the other state regulating conditions for the deposit. Detailed requirements on the agreement and license are stipulated in the Ordinance (1984:14) on Nuclear Activities, sections 19 a and 19 b. Furthermore, detailed provisions, corresponding to Article 4.4 second paragraph (a), (b) and (c) concerning shipment to a third country, are found in Sections 13 d in the Ordinance (1988:293) on Radiation Protection and Sections 19 c of the Ordinance (1984:14) on Nuclear Activities.

Detailed provisions corresponding to the second paragraph in Article 4.4 (a), (b) and (c) about shipment third country exports in the directive are articulated in Sections 13 d in the Ordinance (1988:293) on Radiation protection and Sections 19 c of the Ordinance (1984:14) on Nuclear Activities



E. NATIONAL FRAMEWORK (ARTICLE 5)

Article 5 – National framework

1. *Member States shall establish and maintain a national legislative, regulatory and organisational framework ('national framework') for spent fuel and radioactive waste management that allocates responsibility and provides for coordination between relevant competent bodies. The national framework shall provide for all of the following:*
 - (a) *a national programme for the implementation of spent fuel and radioactive waste management policy;*
 - (b) *national arrangements for the safety of spent fuel and radioactive waste management. The determination of how those arrangements are to be adopted and through which instrument they are to be applied rests within the competence of the Member States;*
 - (c) *a system of licensing of spent fuel and radioactive waste management activities, facilities or both, including the prohibition of spent fuel or radioactive waste management activities, of the operation of a spent fuel or radioactive waste management facility without a licence or both and, if appropriate, prescribing conditions for further management of the activity, facility or both;*
 - (d) *a system of appropriate control, a management system, regulatory inspections, documentation and reporting obligations for radioactive waste and spent fuel management activities, facilities or both, including appropriate measures for the post-closure periods of disposal facilities;*
 - (e) *enforcement actions, including the suspension of activities and the modification, expiration or revocation of a licence together with requirements, if appropriate, for alternative solutions that lead to improved safety;*
 - (f) *the allocation of responsibility to the bodies involved in the different steps of spent fuel and radioactive waste management; in particular, the national framework shall give primary responsibility for the spent fuel and radioactive waste to their generators or, under specific circumstances, to a licence holder to whom this responsibility has been entrusted by competent bodies;*
 - (g) *national requirements for public information and participation;*
 - (h) *the financing scheme(s) for spent fuel and radioactive waste management in accordance with Article 9.*
2. *Member States shall ensure that the national framework is improved where appropriate, taking into account operating experience, insights gained from the decision-making process referred to in Article 4(3)(f), and the development of relevant technology and research.*

E.1 Legislative and organisational framework

The framework of Sweden's legislation in the field of waste management, nuclear safety and radiation protection, is to be found in following Acts:

- The Act (1984:3) on Nuclear Activities, which defines the licensing requirements for the construction and operation of nuclear facilities and for handling or using nuclear materials (including radioactive waste).
- The Radiation Protection Act (1988:220), which defines the licensing requirements for radiation protection and for radiological work.
- The Act (2006:647) on Financing of Management of Residual Products from Nuclear Activities which deals with the main financial aspects, and defines the responsibilities pertaining to the management and disposal of spent nuclear fuel and radioactive waste.
- The Act (1988:1597) on Financing of Certain Radioactive Waste etc., which deals with covering of expenses for management of nuclear waste from older experimental activities. The Act ceased to be in effect at the end of 2017 (see B.7.3).

- The Environmental Code (1998:808)

The Acts are supplemented by a number of ordinances and other secondary legislation, which contain more detailed provisions for particular aspects of the legal framework.

Figure E.1 shows the basic characteristics of the legislative system. The Parliament adopts the laws, which usually contain basic requirements and mandates to the Government or the authority appointed by the Government to issue more detailed requirements. If the government wants to transfer regulatory powers to an authority, this is done by an ordinance. Regulations are often the basis for supervision as they in more detail specifies the level of requirements.

SSM has a mandate to issue regulations under the Act (1984:3) on Nuclear Activities and under the Radiation Protection Act (1988:220). SSM also has the mandate to decide on additional conditions or sanctions on licensed nuclear activities.

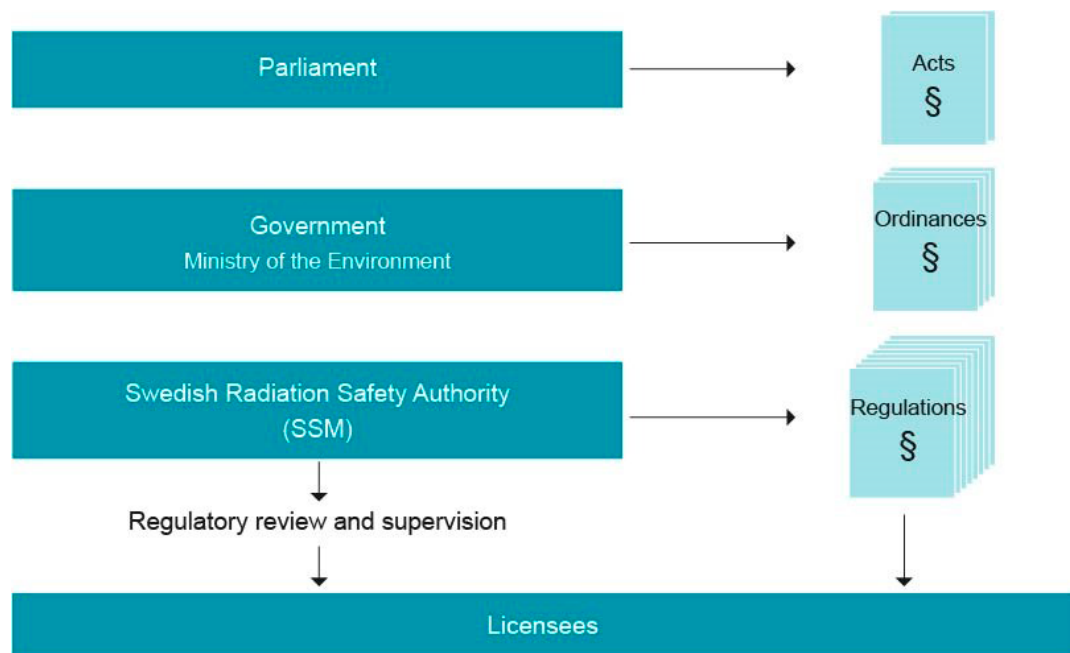


Figure E.1: Principle overview of the Swedish legislative system.

Operation of a nuclear facility can only be conducted in accordance with a licence issued under the Act (1984:3) on Nuclear Activities as well as with a licence issued under the Environmental Code (1988:808). The Act (1984:3) on Nuclear Activities is mainly concerned with issues of safety and security, while the Environmental Code (1988:808) regulates general aspects of the environment and the possible impacts of “environmentally hazardous activities”, to which nuclear activities are defined to belong. The Act and the Code shall be used in parallel and neither of them is superior to the other.

The objective of the Radiation Protection Act (1988:220) is to protect people, animals and the environment from the harmful effects of radiation. The Act applies to radiation protection in general and, in this context, it provides provisions regarding worker’s protection, radioactive waste management, and the protection of the general public and the environment.



The most important regulatory code issued by SSM in the area of safe management regarding safety is the 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 e.g., facilities for handling and storage of spent nuclear fuel and facilities for handling, storage or disposal of nuclear waste.

For disposal facilities there are two other important regulatory documents; The Swedish Radiation Safety Authority's Regulations concerning safety in connection with the disposal of nuclear material and nuclear waste (SSMFS 2008:21), and The Swedish Radiation Safety Authority's Regulations and General Advice 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).

With reference to its legal mandate SSM issues legally binding nuclear safety and radiation protection regulations in its Code of Statutes SSMFS and non-legally binding general advice on the implementation of the safety regulations. The Code of Statutes SSMFS, are issued according to established procedures documented in the management system which stipulates technical and legal reviews of the draft. In accordance with governmental rules, a review of the final draft by authorities, licensees, various stakeholders, and industrial and environmental organizations is performed. In preparation/development of SSM's regulations, EU legislation as well as IAEA safety standards, international recommendations, industrial standards and norms, and the rulemaking of other authorities are considered.

E.2 Licensing system

Any nuclear facility must be licensed according to both the Act (1984:3) on Nuclear Activities and the Environmental Code (1998:808). The Government grants the licence according to the Act on the basis of recommendations and reviews of the competent authority. A Government licence is needed for the construction, possession and operation of a nuclear facility. If significant changes are made to a licensed facility or in the case of de-licensing or exemption from responsibilities, a new Government decision is needed. A licence issued by the Government thus covers the whole lifecycle of the facility. A licence application is reviewed by the regulatory body and the environmental impact assessment is approved by the Land and Environmental Court before the Government's decision. 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. A Government decision related to a nuclear facility includes license conditions, authorizing SSM to approve the construction, commissioning and testing, operation and decommissioning of the facility.

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.

The step by step licensing process as formalised in the legal and regulatory framework for nuclear facilities is on a principle level schematically illustrated in figure C.1 and summarized below. The principle process can as appropriate be applied also for licensing of non-nuclear fuel cycle facilities, e.g. the European Spallation Source ERIC.

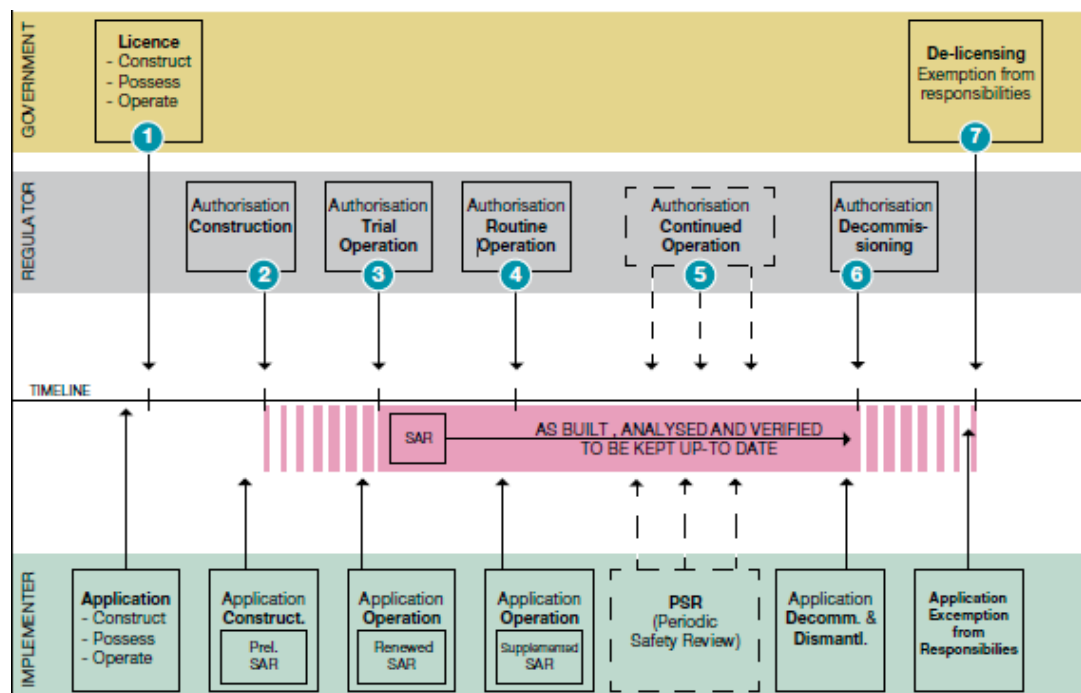


Figure E.1: Schematic visualization of a the step wise licensing process

1. Government licence to construct, possess and operate a nuclear facility

The licence covers the lifecycle of the facility until the licensee is exempted from responsibilities as regards the facility/site. General obligations as regards management of spent nuclear fuel and nuclear waste remains with the licensee until disposal facilities are sealed and closed, and the Government has decided on exemption from those general responsibilities. Review activities according to the Act (1984:3) on Nuclear Activities focus on feasibility to establish the activities and the facility at the proposed site. A parallel licensing process according to the Environmental Code (1998:808) focuses on permissibility and the site selection process.

2. Regulatory authorization to start construction

The authorization is based on a regulatory review of the preliminary safety analysis report (PSAR). Review activities focus on that the preliminary design is compatible with legal and regulatory requirements and according to licence conditions.

3. Regulatory authorization to start trial operation

The authorization is based on a regulatory review of a renewed SAR. Review activities focus on that the facility as built is in compliance with legal and regulatory requirements and according to licence conditions.



4. Regulatory authorization to start routine operation

The authorization is based on a regulatory review of a supplemented SAR taking into account the experience gained from trial operation. Review activities focus on experiences from the trial operation period and that the operation of the facility is in compliance with the operational Limits and Conditions (OLC) and according to licence conditions.

5. Periodic Safety Review (at least every ten years)

The authorization is based on a regulatory review, an integrated analysis and overall assessment of the safety of the facility, concerning the way in which the facility at the time of analysis complies with the valid safety requirements as well as whether the necessary conditions exist to operate the facility in a safe manner until the next review occasion.

6. Regulatory authorization to start decommissioning

The authorization is based on a regulatory review of that the decommissioning plan has been properly supplemented and incorporated into the facility's safety analysis report.

7. Exemption from responsibilities (for the facility) by the Government

The regulatory review focuses on verifying that the licensee has carried out all duties according to the legal and regulatory requirements and according licence conditions. General responsibilities for management and disposal of spent nuclear fuel and nuclear waste remains until all spent fuel and waste is disposed of and disposal facilities are sealed and closed.

E.3 Regulatory control and supervision

E.3.1 Regulatory control and inspections

In accordance with its legal authorisation and the mandate defined by the Government, SSM conducts inspections and assessments of the nuclear facilities to ascertain compliance with regulations and licence conditions. SSM correspondingly also conducts inspections of non-fuel cycle activities requiring a license under the Radiation Protection Act (1988: 808).

SSM executes the supervision of compliance with the Act (1984:3) on Nuclear Activities and the Radiation Protection Act (1988:220), as well as compliance with conditions or regulations imposed under the acts. SSM also fulfils supervision of the compliance with the Environmental Code (1998:808) and conditions or regulations imposed by the Code concerning radiation safety. For other environmental aspects covered by the Code the County Administrative Board conducts supervision. SSM correspondingly also supervises non-fuel cycle activities requiring a license under the Radiation Protection Act (1988: 808).

SSM supervises SKB, the nuclear 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'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. Supervisory strategies are developed so as to facilitate the application of a graded approach in the inspection programmes. Consideration is also given to recommendations from IRRS review missions as well as recommendations from international collaboration.

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

E.3.2 Documentation and reporting

In SSM's Code of Statutes (SSMFS) extensive reporting from licence-holders are required. 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.
- Annual 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.
- Annual report to SSM on the results of environment control.
- Annual information to SSM from all licensees of high activity sealed sources (HASS).

E.3.3 Institutional control

According to regulations on radiation protection, the licence-holder shall conduct environmental monitoring. All discharges from facilities for storage or disposal of radioactive waste shall be monitored by a nuclide specific measuring programme. The dose to any individual in the critical group shall not exceed 0.1 mSv/y. The regulations are applicable to facilities in operation, but the plan is to amend these to also deal with the period following closure of a disposal facility for spent nuclear fuel and radioactive waste.

E.3.4 Provisions for institutional control and monitoring after closure

The holder of a licence for nuclear activities is responsible for ensuring that all measures are taken that are needed for the safe decommissioning and dismantling of facilities in which nuclear activities are no longer to be conducted. Post-closure safety of geological disposal facilities are required to be achieved through containment and isolation of the waste by passive means for the periods of time suited to its radiological hazards. Thus, post-closure institutional control and monitoring is not required for geological disposal facilities.

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 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.



E.4 Enforcement actions

SSM have extensive legal regulatory and enforcement power according to the Act (1984:3) on Nuclear Activities (Sections 16–18), the Radiation Protection Act (1988:220) (Sections 28, 29, 31–34) and the Environmental Code (1998:808) (Chapter 16). In conjunction with the granting of a licence or during the period of validity of the licence, the licensing authority may issue conditions relating to the licence as are required with respect to nuclear safety (Section 8 of the Act on Nuclear Activities) or radiation protection (Section 26 of the Radiation Protection Act).

A licence may be revoked for activities that do not fulfil the obligations set out in the legislation Act on Nuclear Activities (Section 15) and the Radiation Protection Act (Section 28).

If there is an on-going 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 licensee fails to carry out a measure that is mandatory according to 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 licensee's expense.

There are criminal penalty provisions in the Act on Nuclear Activities, the Radiation Protection Act and the Environmental Code. If there is reason to suspect that a penalty sanctioned provision has been infringed, SSM must notify the Prosecutor's Office about the violation.

E.5 Allocation of responsibilities between bodies involved

The legal framework allocates a clear division of responsibilities between the bodies involved. As already mentioned in section D.1.1, the producer of spent fuel and radioactive waste has the responsibility to safely handle and dispose of the waste produced. All necessary measures and precautions have to be taken by the waste producer and the waste producer remains responsible until all necessary measures and precautions have been fulfilled.

E.6 Requirements for public information and participation

The legal framework gives provisions for transparency, openness and public participation in the licensing of nuclear activities. There are several procedures that serve the purpose to involve the public in the siting of new spent nuclear fuel and nuclear waste facilities.

The County Administration 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 an exchange of information.

SSM shall According to the Ordinance with instructions for the Swedish Radiation Safety Authority (2008:452), 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.



An application submitted to the Authority is sent on referral to a large number of stakeholders, e.g. other authorities, the municipality concerned, county administrative boards, universities and NGOs. The application will also be published on the Authority's website and is open for anyone to submit comments on.

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. security aspects or other specified reasons. The Authority provides documents not subject to confidentiality upon request from the general public and journalists.

As part of the preparation of an Environmental Impact Assessment (EIA), an applicant must, before the application documents are submitted, consult with the county administrative board, relevant authorities, the potential host municipality, other stakeholders, the public and NGOs. The purpose of this consultation is to provide information about the planned activities and to obtain comments and suggestions on issues that need to be addressed in the EIA. If the planned activity is large and complex, a number of consultation meetings with different stakeholders may be required. The Authority also participates in consultation meetings primarily intended for the municipality and other stakeholders concerned. The Authority can thus explain its role in the assessment process and the legal requirements underlying the review of the application.

According to the Act (2006:647) and Ordinance (2017:1179) 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 reimbursements. A corresponding process allows for the county administrative boards in Uppsala and Kalmar to be reimbursed to cover costs related to the siting and licensing of nuclear facilities in those counties.

Since 2005 non-profit non-governmental organisations may be reimbursed for costs incurred in relation to their engagement in consultations related to disposal of spent nuclear fuel and radioactive waste. Decisions concerning reimbursement to municipalities and non-profit organisations are made by SSM.

E.7 Financing arrangements for management of spent fuel and nuclear and radioactive waste

Basic requirements related to obligations to cover the costs for management and disposal of spent fuel and radioactive waste are found in Section 13 of the Act (1984:3) on Nuclear Activities. It is explicitly stated that anyone who has a license to conduct nuclear activities is bound to be responsible for the cost of the measures referred to in Sections 10-12 of the act, i.e. for (subsequent) management and disposal of spent fuel and nuclear waste.

Detailed provisions are found in the Act (2006:647) and Ordinance (2017:1179) on Financing of Management of Residual Products from Nuclear Activities.



With regard to non-nuclear fuel cycle activities where radioactive material is used for example for medical purposes, industry, agriculture, research and education, any party that has produced radioactive waste is, according to Section 13 of the Radiation Protection Act (1988:220), required to ensure the safe management and disposal of the waste, including securing financial resources.

The Ordinance (2007:193) on Producer Liability for certain radioactive products and radioactive sources with no owner also regulates the management of radioactive waste. For more information on financial provisions, see also section I on financial resources.

E.8 Improvements to the legislative and organisational framework

The general procedure for introducing new legislation or major amendments of current legislation, is by setting up a Committee of inquiry appointed by the Government. The purpose is to investigate the issues in a comprehensive manner. To optimize the process and to ensure that no negative effects of the proposal will arise, the Committee or inquiry is staffed with people with the necessary expertise.

When SSM finds it necessary to introduce new regulations or revise current regulations, the Authority has to follow a specific procedure established in SSM's management system. Before a project is started an analysis report is required which among other things will summarize experiences of the supervisory activities or other background that causes the need for regulations. In addition, before an authority decides on regulations or general advice, the authority - in the extent necessary in each case – must investigate the cost implications and other consequences. Hereby SSM considers all consequences for not only the licensees but also the society in general before deciding upon new or revised regulations.

The improvement of the legislative and regulatory framework can be based on different aspects, e.g.:

- Incidents at the facilities significant to safety are reported according to the relevant reporting requirements in SSMFS 2008:1. Hereby SSM is informed not only about the incident itself but also safety significance and circumstances which may have caused the incident. From the reporting, SSM may draw conclusions which are important when evaluating the need for updating of the framework.
- From the general supervisory function point of view, the authority may observe tendencies in different safety issues which in the long term can be necessary to meet with new or revised requirements or recommendations. This is a constantly ongoing process at SSM.
- The outcome of the periodic safety reviews can contribute to the knowledge that clarification of current provisions may be necessary. In general, the regulatory reviews of the Periodic Safety Review (PSR) reports have supported the safety improvement programmes adopted by the licensees.
- International peer reviews give valuable input to improvement of the national framework. The IRRS mission in Sweden in 2012 is a clear example. One of the recommendations regarded SSM's regulations. The report on the IRRS review recommended that SSM review the existing regulatory framework and make it clearer, more consistent and comprehensive. SSM has now begun a major review of its regulations.



F. COMPETENT REGULATORY AUTHORITY (ARTICLE 6)

Article 6 – Competent regulatory authority

- 1. Each Member State shall establish and maintain a competent regulatory authority in the field of safety of spent fuel and radioactive waste management.*
- 2. Member States shall ensure that the competent regulatory authority is functionally separate from any other body or organisation concerned with the promotion or utilisation of nuclear energy or radioactive material, including electricity production and radioisotope applications, or with the management of spent fuel and radioactive waste, in order to ensure effective independence from undue influence on its regulatory function.*
- 3. Member States shall ensure that the competent regulatory authority is given the legal powers and human and financial resources necessary to fulfil its obligations in connection with the national framework as described in Article 5(1)(b), (c), (d) and (e).*

F.1 Legal foundations of the regulatory authority

The Swedish Radiation Safety Authority (SSM) is a central administrative authority under the auspices of the Ministry of the Environment and Energy. SSM is the regulatory body in Sweden authorised to supervise spent fuel management and radioactive waste management in the areas of nuclear safety and security, radiation protection and nuclear non-proliferation. According to the Swedish constitution, the administrative authorities are quite independent within the legislation and statutes given by the Government.

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

F.2 Independence of the regulatory authority

The independence from political pressure and promotional interests is well provided for in Sweden. SSM performs its regulatory work autonomously and independently. The laws governing SSM concentrate 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 and Energy. The ministry has several ministers with different responsibilities within the ministry. The responsibility for nuclear regulation and energy policy is effectively divided within the Ministry, between the Minister of the Environment and the Minister of Energy. The Ministry of Enterprise and Innovation represents the Government's ownership in Vattenfall AB (the owner of seven nuclear power reactors in Sweden).

All Government matters are decided on collectively by the Ministers, in Cabinet. The Government directs its authorities through budget appropriations and ordinance decisions on tasks and the general orientation of operations, but it has no powers to intervene in the Swedish Radiation Safety Authority's decision-making in applying the law or discharging its authority in individual cases. An individual minister cannot interfere in a specific case handled by an administrative authority. Ministerial rule is prohibited in Sweden.

The Director General of SSM is appointed by the Government, and responsible for the authority's activities.



F.3 Legal powers and associated relevant legislation

SSM has a legal mandate which enables the authority to issue legally binding safety and radiation protection regulations for nuclear facilities in its Code of Statutes SSMFS (See for example Sections 8 and 9 in the Ordinance (1988:293) on Radiation Protection and Sections 3 a–3 b in the Ordinance (1984:14) on Nuclear Activities). Beyond this, SSM also has the legal powers to impose licensing conditions if necessary due to safety reasons. SSM also has extensive legal powers to enforce its decisions and is authorized to decide in measures that are needed and issue orders and prohibitions in individual cases in order to enforce the Act (1984:3) on Nuclear Activities, regulations or licensing conditions issued with support of the Act.

F.3.1 The Act (1984:3) on Nuclear Activities

According to Section 4 and 9 of the Act the regulatory authority is authorized to issue regulations concerning safety matters and issues regarding verification, testing and inspection. Section 30 of the Act states that the Government or an authority appointed by the Government is authorized to issue regulations concerning fees for the authority's function according to the Act.

According to Sections 16–18 of the Act (and Section 22 of the Ordinance (1984:14) on Nuclear Activities) the supervision of compliance of the Act and the conditions or regulations issued under the Act are exercised by SSM.

According to Section 22 of the Act, SSM can also decide on fines in cases of noncompliance with licence conditions or regulations.

F.3.2 The Radiation Protection Act (1988:220)

Sections 29–33 of the Act (and Section 15 of the Ordinance (1988:293) on Radiation Protection) regulate the supervision of compliance of the Act and the conditions or regulations issued under the Act that are exercised by SSM.

SSM may issue prohibitions when required considering radiation protection (Section 15 the Radiation Protection Act).

F.4 Financial resources

The regulatory activities of SSM are largely 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. In addition, some additional resources are from fees for reviewing special applications or licensing work that are paid directly to the Authority.

The 2017 total turnover for SSM is approximately SEK 510 million.

F.5 Human resources

In 2017, 302 employees worked at the Authority. The staff turnover rate, including retirements, was 13 percent.



Education	Percentage
Postgraduate degree	17
Bachelor's/Master's	73
Upper secondary school	8
Other	2
Total	100

Table F.1: Educational background of SSM staff at the beginning of 2017

Compared with many other authorities, the staff of SSM have a relatively high level of educational background, see Table F.1. 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 Organizations 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.

The Authority performs systematic professional skills assessments and gap analyses for providing SSM's senior management with input on the competence required by the Authority in both the short and long term. The objective is for all employees involved in regulatory supervision to have the same basic skills for performing consistent supervisory work regardless of the area or licensee that is the focus of this supervision.

The purpose of SSM's research is sustaining and developing professional skills of importance for radiation safety work, both in-house on the part of the Authority's employees and on a national level. For these reasons, SSM provides funding not only for basic and applied research, but also for development of methods and processes that lead to improved national competence in the Authority's areas of operation. This also underpins and improves SSM's regulatory supervision.

SSM provides funding for several research projects and research positions at Swedish universities for the purposes of professional development and maintaining expertise and teaching skills. Areas of key importance include reactor physics, severe accidents and non-proliferation. SSM also provides funding for high level research positions in fields such as radiation biology, radioecology and dosimetry. The availability of research funding is also announced in the form of public invitations to apply for funding in the areas of radiation protection and waste management research.



G. LICENCE HOLDERS (ARTICLE 7)

Article 7 –License holders

- 1. Member States shall ensure that the prime responsibility for the safety of spent fuel and radioactive waste management facilities and/or activities rest with the licence holder. That responsibility can not be delegated.*
- 2. Member States shall ensure that the national framework in place require licence holders, under the regulatory control of the competent regulatory authority, to regularly assess, verify and continuously improve, as far as is reasonably achievable, the safety of the radioactive waste and spent fuel management facility or activity in a systematic and verifiable manner. This shall be achieved through an appropriate safety assessment, other arguments and evidence.*
- 3. As part of the licensing of a facility or activity the safety demonstration shall cover the development and operation of an activity and the development, operation and decommissioning of a facility or closure of a disposal facility as well as the post- closure phase of a disposal facility. The extent of the safety demonstration shall be commensurate with the complexity of the operation and the magnitude of the hazards associated with the radioactive waste and spent fuel, and the facility or activity. The licensing process shall contribute to safety in the facility or activity during normal operating conditions, anticipated operational occurrences and design basis accidents. It shall provide the required assurance of safety in the facility or activity. Measures shall be in place to prevent accidents and mitigate the consequences of accidents, including verification of physical barriers and the licence holder's administrative protection procedures that would have to fail before workers and the general public would be significantly affected by ionising radiation. That approach shall identify and reduce uncertainties.*
- 4. Member States shall ensure that the national framework require licence holders to establish and implement integrated management systems, including quality assurance, which give due priority for overall management of spent fuel and radioactive waste to safety and are regularly verified by the competent regulatory authority.*
- 5. Member States shall ensure that the national framework require licence holders to provide for and maintain adequate financial and human resources to fulfil their obligations with respect to the safety of spent fuel and radioactive waste management as laid down in paragraphs 1 to 4.*

G.1 The prime responsibility

According to the Act on Nuclear Activities and 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 Environmental Code, a party conducting an activity 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.

According to the legislative history of 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.

G.2 Rules on the use of contractors in nuclear operation

As a consequence of the implementation of EC Directive 2014/87/Euratom, the prime responsibility of a licensee when using subcontractors have been clearly formalised in the legislation, through an amendment to Section 13 of the Act (1984:3) on Nuclear Activities. This amendment in essence require that a licensee for nuclear activities shall ensure that a contractor shall have the personal resources with appropriate qualifications and skills required for the licensee to fulfil his obligations.

A supplementary amendment has also been introduced in the legislation by means of new Section 16 a, requiring the licensee to provide the supervisory authority the ability to review how safety requirements are followed by contractors, subcontractors or other contractors, to fulfil the legal requirements.

G.3 Continuous improvement

G.3.1 Safety management

The licensees work continuously with safety improvement. All nuclear licensees have safety programmes in place as required by SSM regulations SSMFS 2008:1. The programmes are part of the management system documentation. They contain priorities and time schedules for technical, organisational and administrative measures to be implemented as a result of safety analyses, audits, safety culture surveys and other evaluations done at the facility.

All licensees are committed to maintaining a strong safety culture in their operations. Management at all levels, including the managing directors, is involved in activities to enhance the safety culture and to stress the responsibility of all personnel to work actively in maintaining and developing the safety culture standard.

G.3.2 International cooperation

The nuclear power plant and fuel cycle facility licensees have traditionally been quite active in international cooperation to enhance nuclear safety by sharing experience, contributing to work with international regulations and guidelines and in participating in safety assessments and peer reviews. This is today primarily accomplished through memberships in WANO, in participating in IAEA and OECD/NEA activities and various task forces representing most of the disciplines in nuclear facilities.



G.4 Verification of safety

A number of different verification programmes are used in order to ensure that the physical state and the operation of the nuclear installation continue to be in accordance with its design, safety requirements, and its operational limits and conditions. These programs can be gathered in the groups: surveillance, in-service inspection, preventive maintenance and safety reviews. The following are the most important points.

G.4.1 Surveillance

The operational limits and conditions (OLC) are described in the operational limits and conditions document. The OLC document also clarifies what types and with what frequency functional tests are to be carried out in order to verify that components and systems are ready for operation. These tests are carried out in accordance with documented procedures and all test results are reviewed and documented.

G.4.2 Preventive maintenance

Maintenance is optimised with regard to the relation between corrective and preventive maintenance. The preventive maintenance implemented at the nuclear facilities includes predictive (condition-based), periodic and planned maintenance, and serves the purpose of maintaining equipment within its design and operating conditions and extending its life, thereby eliminating, or at least minimizing, the risk for failures that can limit safe and reliable facility operation. A well-balanced preventive maintenance programme is based on engineering analysis in which safety as well as economic aspects are considered. The programme is well defined and periodically revised as additional operational experience is gained.

Periodic maintenance consists of activity is performed on a routine basis, and may include any combination of external/internal inspection, alignment or calibration, overhaul, and component or equipment replacement. Typically, any deficiencies found by predictive or periodic maintenance are addressed by corrective or planned maintenance.

G.4.3 Periodic safety assessments

The licensees of nuclear installations are according to Section 10a of the Act (1984:3) on Nuclear Activities required to carry out a Periodic Safety Review (PSR) at least every 10 years. The review shall verify that the facility complies with the current safety requirements as well as having the prerequisites for safe operation until the next periodic safety review, taking into account advances in science and technology. The analyses, assessments and proposed measures as a result of the review shall be submitted to SSM. The requirement applies to all nuclear facilities but SSM has been authorized to decide on exemptions when the risks associated with the facility are small.

The outcomes of the PSRs are reported to SSM, who performs a comprehensive review and assessment of the report and its references.



G.5 Safety demonstration

G.5.1 Basic licensing prerequisites

According to the Environmental Code (1998:808) and Act (1984:3) on Nuclear Activities a licence is required to construct, possess and operate any nuclear facility. A licence application must demonstrate that the requirements are fulfilled under those acts as well as the Radiation Protection Act (1988:220). It must further be demonstrated that the more detailed requirements 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 input to the licence application and subsequent applications in the step wise licensing process is the safety analysis report (SAR).

Requirements on the content of the SAR 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 (1988:220) and regulations promulgated according to that act.

See also sections D.1.8 and E.2.

G.5.2 Prevention of accidents and mitigation of consequences

The general safety regulations SSMFS 2008:1 apply to measures required to maintain safety in connection with the construction, possession and operation of nuclear facilities with the aim of, as far as reasonably achievable, taking into account the best available technology, preventing radiological accidents and preventing the unlawful handling of nuclear material and nuclear waste.

According to Chapter 2 Section 1 radiological accidents shall be prevented through a facility-specific and fundamental design which shall incorporate multiple barriers as well as a facility-specific system for defence-in-depth. Defence-in-depth shall be achieved by preventing accidents and mitigate the consequences if an accident does occur.



Chapter 2 Section 3 stipulates that an observed deficiency or if there is reason to suspect that there is a deficiency in a barrier or in the defence-in-depth system, measures shall be taken to the extent and within the time frame necessary depending on the severity of the deficiency. For this purpose, the deficiencies shall be evaluated, classified and investigated without delay.

Chapter 4 Section 1 requires an analysis of a facility's barriers and defence- in-depth system to prevent radiological accidents and mitigate the consequences in the event of an accident.

More specific requirements on design and construction are given in Chapter 3 of SSMFS2008:1. These can be summarized in the following points. The design shall:

- Be able to withstand component and system failures,
- Be reliable and have operational stability,
- Be able to withstand such events and conditions which can affect the safety function of the barriers or defence-in-depth, as well as
- Make it possible to maintain, inspect and test structures, systems and components and as far as reasonable facilitate a safe future decommissioning.

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

G.5.3 Prevention of accidents during the operation

According to SSMFS 2008:1 Chapter 5 Section 1, the licensee is obliged to establish procedures which have been drawn up for measures to be taken at a facility during normal operation, abnormal operation and design basis accidents.

It is also necessary for the licensees to establish documented guidelines for measures which may be necessary to implement in order to control and mitigate the consequences of beyond design basis accidents.

The operational limits and conditions for nuclear facilities are included in an operational document named STF (Säkerhetstekniska driftförutsättningar) corresponding to Operational Limits and Conditions (OLC). This document is considered one of the cornerstones in the governing and regulation of the operations of nuclear facilities.

G.5.4 Mitigation of consequences of accidents

SSM's regulations SSMFS 2008:1 require the licensee, in the event of emergencies, to take prompt actions in order to:

- Classify the event according to the alarm criteria,
- Alert the facility's emergency preparedness organisation,
- Assess the risk for 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 shall be notified of changes in the plan.

The SSM regulations SSMFS 2008:15 on emergency planning and preparedness at nuclear installations 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
- Alarm criteria and alarming
- Emergency rooms/premises/facilities
- Assembly places
- Iodine prophylaxis
- Personal protective equipment
- Evacuation plan
- Training and exercises
- Contacts with SSM
- Radiation monitoring
- Emergency ventilation
- Collection of meteorological data.

Depending on the radiological hazard potential, the requirements regarding radiation monitoring, emergency ventilation, and collection of meteorological data differ between the facilities.

G.6 Management systems

G.6.1 Regulatory requirements on management systems

The SSM general safety regulations SSMFS 2008:1, Chapter 2, Section 8 require that nuclear activities with regard to design and construction, operation and decommissioning, shall be managed, controlled, assessed and developed through a management system so designed that requirements on safety will be met. The management system, including the necessary routines and procedures, shall be kept up to date and be documented. This view on quality and safety being integrated with other business concerns into a total integrated management system is in line with the IAEA Safety Requirements on Management Systems, GS-R-3.

It is further required in SSMFS 2008:1 that the application of the management system, its efficiency and effectiveness, shall be audited systematically and periodically by a function having an independent position in relation to the activities being audited. An established audit programme shall exist at the 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 contractors and vendors are to be audited, 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 organization and should report to the highest management of the facility. The audits should have continuity and auditors should have good knowledge about activities being audited.



G.6.2 Main features of the management systems implemented by the licensees

The licence holders have integrated management systems where requirements addressed to the operation are provided for in a systematic manner. Safety issues have a special status in the management systems.

The main features of the licence holder's management systems can be summarized in the following areas:

- The structure of the management system
- How requirements regarding radiation safety are converted and met
- Aims and guidelines for radiation safety
- Structure, responsibility and decision-making of the organization
- How organization modifications are handled
- Procedures for competence assurance
- The operative radiation protection work
- Activities and eventual processes identify process owners plus how activities and processes are evaluated and developed
- Interaction with external organizations of importance for radiation safety
- How the requirements on radiation safety are satisfied when tendering products and services
- How guiding documents shall be initiated, reviewed, approved and revised.

G.6.3 Verification of the management system

In a systematic and continuous manner SSM follows-up how the management system is structured and how the licensees work with its suitability as an integrated part of the inspection programme. Important factors are that the management systems are up-dated and how the licensees deal with requirements management.

Furthermore, SSM also carries out random sampling within different areas. The purpose is to review how a specific area, for example system for feedback of experience, is controlled and applied by the management systems.

G.7 Licensees financial and human resources

According to Section 13 of the Act (1984:3) on Nuclear Activities, a licensee is obliged to have an organisation for the activity with sufficient financial, administrative and human resources to uphold safety and to take protective measures in the event of disruptions in the operations or accidents in the facility.

The legal requirement clarifies the licensee's obligation to have an organization formed and staffed in such a manner that it ensures a safe and reliable operation of all activities related to nuclear safety and meets the need for effective measures in an emergency situation. This applies even to the contractors hired by the licensee.

Great importance is given to the licensee's ability to be responsible for the obligations arising from the nuclear activities. The licensee must demonstrate the financial capacity to meet far reaching obligations in a long term.

In addition to this basic requirement, the Act (2006:647) on Financing of Management of Residual Products from Nuclear Activities defines the responsibilities pertaining to the



management and disposal of spent nuclear fuel and radioactive waste. The Act lays down the principles for the financing of expenses for the future decommissioning and disposal of spent nuclear fuel and nuclear waste for all nuclear licensees. 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 for nuclear facilities. Apart from the fees to be paid to the nuclear waste fund, the licensees must also provide guarantees in case a facility is closed prematurely and to cover contingencies. The financing system is described more in detail in section I (Article 9) in this report.



H. EXPERTISE AND SKILLS (ARTICLE 8)

Article 8 – Expertise and skills:

Member States shall ensure that the national framework require all parties to make arrangements for education and training for their staff, as well as research and development activities to cover the needs of the national programme for spent fuel and radioactive waste management in order to obtain, maintain and to further develop necessary expertise and skills.

H.1. Legal requirements concerning education and training

According to the general regulations SSMFS 2008:1 the licensee has to ensure that the staff has the competence and suitability needed for all tasks of importance for safety and this has to be documented. Long-term planning is required in order to ensure enough staff with sufficient competence and suitability for the safety related tasks are available. A systematic approach should be used for the definition of competence requirements, planning and evaluation of all safety related training. Annual competence assessments shall be performed. These general requirements apply also to the extent applicable on the use of contractors. It is also a requirement that there is a careful balance between the use of in-house personnel and contractors for safety related tasks. The competence necessary for ordering, managing and evaluation of the results of contracted work should always exist within the organization of a nuclear installation.

H.2. Education and training of the staff of the licence holders

All licensees are required to have an established process for competence assurance. SSM is the appointed authority to supervise the licensees compliance to the requirements. The process usually consists of the following parts:

- Identification of tasks relevant for safety,
- Identification of existing staff competence
- Identification of relevant and necessary staff competence
- Performing a gap analysis.

In view of the performed gap analysis, the licensees develop relevant educational programmes or training in order to achieve the right skills among the staff, both in short and long term perspective.

All licensees have a systematic approach in place for the training of staff, as required. Training programmes are developed based on task analysis and definitions of required competence. A systematic method is also used to define any re-training that is required.

H.3. Education and training on the national level

The academic institutions are a source of specialists to the nuclear sector. The Government is responsible for funding of basic university training. Experimental research within safety and radiation protection is performed at Chalmers University, Royal Institute of Technology, Uppsala University, Stockholm University and Lund University.

SSM is by Government ordinance tasked with contributing to development of national competence within the Authority's areas of operation. The purpose of SSM's research is sustaining and developing professional skills of importance for radiation safety work, both in-house on the part of the Authority's employees and on a national level. For these reasons, SSM provides funding for several research projects and research positions at



Swedish universities, not only for basic and applied research, but also for development of methods and processes that lead to improved national competence in the Authority's areas of operation. The availability of research funding is also announced in the form of public invitations to apply for funding in the areas of radiation protection and waste management research. Research in the areas of final disposal of spent nuclear fuel and decommissioning of nuclear facilities is financed through the Nuclear Waste Fund. Funding is for example awarded to research projects on canister corrosion, biosphere processes, bentonite and backfill, geosphere processes, fuel processes and consequence/impact analyses. The purpose of this research is to provide input for ongoing and future reviews, including impending review elements as part of the step-wise licensing processes that disposal facilities are subject to. The research funding also has the aim of longer term maintenance of know-how, skills and continuity in areas, fields and disciplines relating to final disposal of radioactive waste. Alongside the funding for research projects, the Authority provides funding to researchers at institutions of higher education.

H.4. Education and training of the staff of the regulatory authority

A long-term plan on competence needs for SSM was established after the forming of SSM in 2008 and it is continuously up-dated with systematic professional skills assessments and gap analyses to provide SSM's senior management with input on the competence required by the Authority in both the short and long term.

On the basis of individual competence development plans, all employee competence needs are identified on a yearly basis and training is performed to meet both individual and operational needs. An average of 5-6 days per employee are used for training and skills development each year, besides "on the job" training and mentorship assignments. Individual needs of training courses and competence development in general are usually met by training courses on the market.

A basic training programme is given to all new employees 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. On the part of SSM management, development efforts include leadership programmes and organisational and systems skills.

As mentioned above, SSM's funding of research contributes to sustaining and developing professional skills of importance also for the Authority's radiation safety work. 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.



I. FINANCIAL RESOURCES (ARTICLE 9)

Article 9 – Financial resources:

Member States shall ensure that the national framework require that adequate financial resources be available when needed for the implementation of national programmes referred to in Article 11, especially for the management of spent fuel and radioactive waste, taking due account of the responsibility of spent fuel and radioactive waste generators.

I.1. Nuclear power plants

The financing system to secure the financing of the nuclear power plant licensees' future costs for the management and disposal of spent nuclear fuel and nuclear waste was established in 1981. The main objective with the arrangements 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 a detailed report including all cost estimates is 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 50 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 the 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.

Apart from the payment of fees, a reactor owner shall provide two forms of guarantees.

One guarantee covers fees that, although decided, have not yet been paid. The basis for this guarantee is referred to as the financing amount. The calculation is basically conducted in the same way as for the fee basis, but the costs are limited to the management and disposal of those residual products that exist when work on the calculation commences. In this report on 31 December 2017.

The second guarantee refers to the situation in which it can be assumed that the assets in the Nuclear Waste Fund will be inadequate as a consequence of unforeseen events, at the same time as the option of increasing the payment of fees and adjusting the aforementioned guarantee is not available for some reason. The basis for this guarantee is referred to as the supplementary amount.

I.2. Other nuclear facilities

Licensees for nuclear facilities other than nuclear power reactors 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. 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.

I.3. Legacy waste

A special fee is levied on the nuclear power utilities according to the Act (1988:1597) on Financing of Certain Radioactive Waste etc., which deals with covering of expenses for management of nuclear waste from older experimental activities. 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 Act ceased to be in effect at the end of 2017, and future disbursements from the fund will be regulated through the Act (2006:647) on Financing of Management of Residual Products from Nuclear Activities.

In addition, there is a state financing scheme for the clean-up of orphan sources and other legacy waste that is administered by SSM through the Swedish Environmental Protection Agency's appropriation "1:4 Remediation and restoration of contaminated areas".

I.4. Radioactive waste from non-nuclear activities

With regard to non-nuclear activities where radioactive material is used for example for medical purposes, industry, agriculture, research and education, any party that has produced radioactive waste is, according to Section 13 of The Radiation Protection Act (1988:220), required to ensure the safe management of such waste, including securing of financial resources.



J. TRANSPARENCY (ARTICLE 10)

Article 10 - Transparency

1. *Member States shall ensure that necessary information on the management of spent fuel and radioactive waste be made available to workers and the general public. This obligation includes ensuring that the competent regulatory authority inform the public in the fields of its competence. Information shall be made available to the public in accordance with national legislation and international obligations, provided that this does not jeopardise other interests such as, inter alia, security, recognised in national legislation or international obligations.*
2. *Member States shall ensure that the public be given the necessary opportunities to participate effectively in the decision- making process regarding spent fuel and radioactive waste management in accordance with national legislation and international obligations.*

J.1 Legal requirements for making information available to the public

The right of public access to official records is inscribed in the Swedish constitution. All official documents are public unless a decision is made to classify them according to the Public Access to Information and Secrecy Act (SFS 2009:400). The reasons for confidentiality could be national security, international relations, commercial relations, or the individual right to privacy. To see a public document there is no need to justify or to reveal identity to have access to such document. If an authority has rejected a request to obtain a document, the applicant is generally entitled to appeal against the decision. Appeals are made to the administrative court of appeal.

SSM's missions and tasks are defined in the Ordinance (2008:452) with instructions for the Swedish Radiation Safety Authority. According to Section 7 SSM is responsible to contribute toward public insight into all activities performed by the authority.

The Swedish right of public access to official records not only gives the public and mass media the right to gain insight into SSM's organisation and its work, but also the right to access the Authority's official documents, provided they are not subject to secrecy. SSM's online register (e-registry), which contains details about the Authority's registered items of business, is available to the general public from the website. All reports issued by SSM may be ordered. Some are downloadable from the SSM website. An emergency website linked to SSM's public website can be activated during an event or accident with a radiation hazard.

Public insight and the tasks of local safety boards are regulated by the Act (1984:3) on Nuclear Activities and by Ordinance (2007:1054) on Instructions for the Local Safety Boards of Nuclear Facilities. A party that holds a licence to operate a nuclear power or research reactor, or a facility for the production, management, processing, storage or disposal of nuclear material or nuclear waste, is under an obligation to provide the local safety board with the insight necessary for it to be able to inform the public on the safety and radiation protection work at the facility.

J.2 Public's opportunity to participate in the decision-making process

The legal framework for the licensing of nuclear activities gives provisions also for transparency, openness and public participation. There are several procedures that serve the purpose to involve the public in the siting of new spent nuclear fuel and nuclear waste facilities.



As mentioned in section E.6 of this report, an EIA (Environmental Impact Assessment) must be performed for any new nuclear facility or any nuclear facility applying for a new license. The 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 on 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 Administration 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 an exchange of information.

According to the Act (2006:647) and Ordinance (2017:1179) 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. Currently, the municipalities of Östhammar and Oskarshamn are receiving reimbursement. Since 2004 it is also possible for non-profit, non-governmental organisations to apply for financial support to participate in activities related to disposal of spent nuclear fuel and radioactive waste.

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.



K. IMPLEMENTATION OF THE NATIONAL PROGRAMME (ARTICLES 11 AND 12)

K.1 National Programme

Article 11 – National programs

1. Each Member State shall ensure the implementation of its national programme for the management of spent fuel and radioactive waste ('national programme'), covering all types of spent fuel and radioactive waste under its jurisdiction and all stages of spent fuel and radioactive waste management from generation to disposal.
2. Each Member State shall regularly review and update its national programme, taking into account technical and scientific progress as appropriate as well as recommendations, lessons learned and good practices from peer reviews.

Article 12 – Contents of national programmes:

- 1 The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:
 - (a) the overall objectives of the Member State's national policy in respect of spent fuel and radioactive waste management;
 - (b) the significant milestones and clear timeframes for the achievement of those milestones in light of the overarching objectives of the national programme;
 - (c) an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;
 - (d) the concepts or plans and technical solutions for spent fuel and radioactive waste management from generation to disposal;
 - (e) the concepts or plans for the post-closure period of a disposal facility's lifetime, including the period during which appropriate controls are retained and the means to be employed to preserve knowledge of that facility in the longer term;
 - (f) the research, development and demonstration activities that are needed in order to implement solutions for the management of spent fuel and radioactive waste;
 - (g) the responsibility for the implementation of the national programme and the key performance indicators to monitor progress towards implementation;
 - (h) an assessment of the national programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time;
 - (i) the financing scheme(s) in force;
 - (j) a transparency policy or process as referred to in Article 10;
 - (k) if any, the agreement(s) concluded with a Member State or a third country on management of spent fuel or radioactive waste, including on the use of disposal facilities.
2. The national programme together with the national policy may be contained in a single document or in a number of documents.

A comprehensive account of national policies, the legal and organisational framework and strategies (national program) governing the management of spent fuel and nuclear and radioactive waste can be found in the national plan [1], published in 2015, and notified to the European Commission. The developments taken place since the notification of the national plan are described in the main reference documents with specific relevance to management of spent nuclear fuel and nuclear and radioactive waste, i.e. the RD&D-program 2016 [2] and the Plan report 2016 [3].



Recent development as regards management and disposal of spent fuel and radioactive waste are presented in section B, Summary. No significant changes in the program for management and disposal of spent fuel and radioactive waste is identified, that would warrant an update of the national plan.

The Swedish national reports to the Joint Convention provides comprehensive updated overviews of the status for management of spent nuclear fuel and nuclear and radioactive waste in Sweden. In order not to duplicate detailed information in this report, reference is made to relevant information in the most recent national report under the Joint Convention [4].

K.2 Reporting of inventories and future prospects

An overview of current and estimated future volumes of radioactive waste and spent fuel arising is presented in Appendix 1.



L. PEER REVIEWS AND SELF-ASSESSMENTS (ARTICLE 14.3)

Article 14 – Reporting

3. *Member States shall periodically, and at least every 10 years, arrange for self-assessments of their national framework, competent regulatory authority, national programme and its implementation, and invite international peer review of their 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 of any peer review 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..*

In May 2016, SSM underwent an international review of Sweden's compliance with IAEA standards in the form of an IRRS (Integrated Regulatory Review Service) review mission. The review was a follow-up of the full scope IRRS mission that took place in February 2012. The follow-up mission concluded that the Swedish system for nuclear safety and radiation protection is solid and continues to show good progress. The Authority has taken into consideration and dealt with the recommendations and suggestions made during the 2012 review. New areas for improvement were identified as well as good practices, including a regulatory risk management approach and a comprehensive and integrated development of revised regulations.

Sweden is planning for a new full-scope IRRS mission, as well as an ARTEMIS mission to be carried out in 2022.



M. MAIN SOURCES OF INFORMATION

1. Safe and responsible management of spent nuclear fuel and radioactive waste in Sweden, SSM report 2015:32, August 2015
2. RD&D Programme 2016. Programme for research, development and demonstration of methods for the management and disposal of nuclear waste, SKB TR-16-15, September 2016
3. Plan 2016. Costs from and including 2018 for the radioactive residual products from nuclear Power. Basis for fees and guarantees for the period 2018–2020, SKB TR-17-02, April 2017
4. Sweden's sixth national report under the Joint Convention on the safety of spent fuel management and on the Safety of radioactive waste management, Ds 2017:51
5. ENSREG Working Group 2, Guidelines for Member States reporting on Article 14.1 of Council Directive 2011/70/Euratom, ENSREG, January 2018



Appendix 1. Reporting of national inventories and the future prospects of radioactive waste and spent fuel under the Directive. Reference date: 2016-12-31

Table 1: Solid Radioactive Waste in Storage.

Waste Class	Total Current Volume (m ³) ⁵	Estimated Disposal Volume (m ³)	Planned Disposal Route ³
VLLW-SL	2900	2900	NSF-2
LILW-SL	8500	8500	UF-2
LILW-LL	5300	5300	UF-2

Table 2: Liquid Radioactive Waste in Storage

Waste Class	Total Current Volume (m ³)	Estimated Disposal Volume (m ³)	Planned Disposal Route (if known)
Line for each class (as per national classes or international classification)	- (m ³)	- (m ³)	
Line for each class (as per national classes or international classification)	- (m ³)	- (m ³)	

Table 3a: Solid Radioactive Waste Disposed (as disposed volume)

Waste Class	Volume (m ³)	Disposal Route Used ⁶
VLLW-SL	27 841	NSF-2
LILW-SL	38 922	UF-2
LILW-LL	0	-
HLW	0	-

Table 3b: Liquid Radioactive Waste Disposed (as disposed volume)

Waste Class	Volume (m ³)	Disposal Route Used
Line for each class (as per national classes or IAEA classification)	- (m ³)	

⁵ Total current volume means the total volume of conditioned and unconditioned waste.

⁶ Four main types – UF-1: underground (HG); UF-2: underground (NHG); NSF-1: engineered near surface; NSF-2: non-engineered near surface (as per EGIRM definitions)



Table 4: Spent fuel in Storage (MTHM). For information on location, number of assemblies and type of fuel consult Sweden's 6th report under the Joint Convention. Ds 2017:51. Section D, tables D1 - D3.

Type	Current Amount (NPP)	Current Amount (Research Reactors and others)
Total Spent Fuel Storage	6756 MTHM	2.74 MTHM
Wet storage (AR)	492 MTHM	0.04 MTHM
Wet storage (AFR)	6264 MTHM	2.7 MTHM
Dry storage (AR)	-	-
Dry storage (AFR)	-	-
Total spent fuel held in storage for other countries (amounts also included above)	-	-

AR = "at reactor site", including fuel pools at NPP

AFR = "away from reactor site"

Table 5: Spent fuel sent for reprocessing (in the country or sent to another country)⁷ (MTHM)

Type	Amount (NPP)	Amount (Research Reactors and others)
Total amount of national Spent Fuel sent for reprocessing (in your country)	- MTHM	- MTHM
Total amount Spent Fuel sent to reprocessing (in another country) ⁸	236 MTHM	- MTHM
Total amount of Spent Fuel received from another country for reprocessing	- MTHM	- MTHM
Total amount of spent fuel reprocessed in your country	- MTHM	- MTHM
Current reprocessing capacity in your country	- MTHM/year	- MTHM/year

⁷ All years to date (i.e. includes spent fuel sent for reprocessing in previous years which has already been reprocessed). This represents historical data as the national strategy for spent fuel is direct disposal without reprocessing.

⁸ This includes also spent fuel repatriated for other purposes.



Table 6: Future prospects (volumes of waste and spent fuel arising, waste and spent fuel management facilities)

Type	Total Amount (at reference date)	Estimated total amount when prepared for disposal*	Total disposal capacity (at reference date)	Total forecast at 2030	Total disposal Capacity in 2030	Total forecast at 2050	Total disposal Capacity in 2050
Spent Fuel Storage	6759 MTHM			9500 MTHM		4000 MTHM	
Total amount Spent Fuel sent to reprocessing ⁴	236 MTHM			0 MTHM		0 MTHM	
Total amount Spent fuel disposed	0 MTHM		0 MTHM	0 MTHM	0 MTHM	8 000 MTHM	12 600 MTHM
Waste in storage:	16 700 m ³	16 700 m ³		43 500 m ³		15 000 m ³	
VLLW	2900 m ³	2900 m ³		2000 m ³		0 m ³	
LILW-SL	8500 m ³	8500 m ³		30 000 m ³		5 000 m ³	
LILW-LL	5300 m ³	5300 m ³		11 500 m ³		10 000 m ³	
Waste in disposal:	66 763 m ³		101 540 m ³	111 540 m ³	233 540 m ³	198 540 m ³	249 540 m ³
VLLW	27 841 m ³		38 540 m ³	51 540 m ³	53 540 m ³	53 540 m ³	53 540 m ³
LILW-SL	38 922 m ³		63 000 m ³	60 000 m ³	180 000 m ³	140 000 m ³	180 000 m ³
LILW-LL	0 m ³		0 m ³	0 m ³	0 m ³	5000 m ³	16 000m ³

Assumptions in the forecast include six nuclear reactors planned for long-term operation (up to 60 years) and seven reactors planned for or in decommissioning. In the forecast for 2030 the amount of waste in storage is expected to be higher because of a planned pause for six years in disposal of waste in SFR due to the construction of the extended SFR. In the forecast for 2050 it is assumed that no additional shallow landfill facilities will be constructed.

Sources of data and references

The Swedish national profile was prepared with the reference date 2016-12-31 for inventories of spent fuel and radioactive waste. Main sources of data have been annual reports of active waste management from the licensees.