StrålevernRapport ▪ 2014:7

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

National Report from Norway to the fifth review meeting, 11–22 May 2015

Statens strålevern
Norwegian Radiation Protection Authority

Reference:
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. National report from Norway to the fifth review meeting, 11–22 May 2015. StrålevernRapport 2014:7. Østerås: Norwegian Radiation Protection Authority, 2014.

Key words:
Spent fuel and radioactive waste management.

Abstract:
This report describes the overall situation of the spent fuel and radioactive waste management in Norway. This national report is submitted to the fifth review meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of the Radioactive Waste Management to be held on 11–22 May 2015

Referanse:
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. National report from Norway to the fifth review meeting, 11–22 May 2015. StrålevernRapport 2014:7. Østerås: Statens strålevern, 2014.

Emneord:
Brukt brensel og radioaktivt avfall

Resymé:
Rapporten beskriver generell sitasjon om sikker håndtering og behandling av brukt brensel og radioaktivt avfall i Norge. Rapporten er submittert til det femte tilsynsmøte til felleskonvensjonen om sikker håndtering av brukt brensel og sikker håndtering av radioaktivt avfall som blir avholdt 11.–22. mai 2015.

Head of project:Naeem Ul Hasan Syed.
Approved:

Ole Harbitz, Director General

---

40 pages.
Published 2014-12-20
Cover design: 07 Media
Printed by 07 Media
Coverphoto:

Norwegian Radiation Protection Authority, P.O. Box 55, N-1332 Østerås, Norway
Telephone +47 67 16 25 00, fax + 47 67 14 74 07
www.nrpa.no
ISSN 1891-5191 (online)
ISSN 0804-4910 (print)

StrålevernRapport 2014: 7

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

National Report from Norway to the fifth review meeting, 11 – 22 May 2015

Statens strålevern

Norwegian Radiation
Protection Authority
Østerås, 2014

List of Abbreviations

HBWR	Heavy Water Boiling Reactor
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
IFE	Institute for Energy Technology
JEEP	Joint Establishment Experimental Pile
KLDRA	Combined Storage and Repository for Radioactive Waste
LILW-LL	Low and Intermediate Level Waste – Long Lived
LILW-SL	Low and Intermediate Level Waste – Short Lived
LLW	Low Level Waste
MOH	Ministry of Health and Social Care
MTIF	Ministry of Trade, Industry and Fisheries.
MTO	Man, Technology and Organisation
NORA	Norwegian 0 (zero) - power Reactor Assembly
NOU	Official Norwegian Report
NRPA	Norwegian Radiation Protection Authority
OECD	Organisation for Economic Co-operation and Development
TE-NORM	Technologically Enhanced –Naturally Occurring Radioactive Material
WATRP	Waste Management Assessment and Technical Review Programme

Contents

A. Introduction

This is the Norwegian report to the fifth review meeting to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) to be held at IAEA in Vienna, 11–22 May 2015. Norway signed the Joint Convention on 29 September 1997, the day it was opened for signature. The Joint Convention was ratified and the ratification deposited on 12 January 1998.

This report is prepared by the Norwegian regulator authority, Norwegian Radiation Protection Authority (NRPA), with the assistance of the Institute of Energy Technology (IFE). The report has been written in accordance with the "Guidelines regarding the Form and Structure of National Reports", as established by the Contracting Parties under Article 29 of the Convention at the Preparatory Meeting held at IAEA from 10–12 December 2001, as amended by the second Extraordinary Meeting of the Contracting Parties held from 12 – 13 May 2014.

This fifth report is a revision of the fourth report. The comments, questions and remarks given to Norway's initial national report and Norway's presentation given during all the previous review meetings have been incorporated in this report. The guidelines set out in the IAEA working document "Use of safety standards in relation to the Joint Convention" of March 2005, have been applied, and references to the use of the IAEA Safety Standards in Norway have been supplied where appropriate.

This report concludes that Norway meets the obligations of the Joint Convention. However, the relevant Norwegian authorities will aim for further improving the waste management policy to further enhance safety, in line with the aims of the Joint Convention.

B. Policies and Practices

Article 32. Reporting (1)

Norwegian nuclear activities started in 1948 with the establishment of Institute for Atomic Energy, later renamed the Institute for Energy Technology (IFE), at Kjeller east of Oslo. In July 1951 the first research reactor, JEEP I, reached criticality. It was followed by the Halden Boiling Heavy Water Reactor (HBWR) in Halden, southeast of Oslo, in 1959. The NORA reactor, built at Kjeller in 1961, was shut down in 1968 and later decommissioned. JEEP I was decommissioned in 1967. JEEP II was built in 1965–66 and reached criticality in December 1966. At present, the JEEP II at Kjeller and the HBWR in Halden are in regular operation. JEEP II has a thermal capacity of 2 MW. The HBWR has a thermal capacity of 25 MW; however, it is operated below 20 MW. Both reactors are owned and operated by IFE. A radioactive waste management facility started operation in 1959 at Kjeller and the Combined Disposal and Storage Facility for low and intermediate level waste in Himdalen, approximately 26 kilometres south-east of the Kjeller site has been in operation since 1999.

The management of spent nuclear fuel in Norway has gone through various phases. The first core loading in HBWR was stored after its discharge in 1961. In the 1960s, reprocessing was an emerging technology, and spent fuel from JEEP I was used as loading material in a pilot reprocessing plant at the Kjeller site. This plant was in operation from 1961 to 1968, and was later decommissioned. However, reprocessing was still considered a viable option for the forthcoming Norwegian fuel cycle, the second core loading in HBWR was reprocessed in Belgium in 1969. The uranium and plutonium gained from the reprocessing was sold for civilian use, and the waste was disposed of in Belgium. When the third core loading was discharged, reprocessing was no longer a politically viable option; consequently, this and later discharged spent fuel from the HBWR are stored on site, together with the discharged first core loading. The remainder of the spent fuel from the JEEP I reactor, along with spent fuel from the NORA and JEEP II reactors, are being stored at Kjeller. Radioactive waste from the pilot plant is today disposed of at the combined disposal and storage facility in Himdalen. The remaining quantities of low-level liquid uranium solution have been solidified. Further details are given in section H of this report.

Existing spent fuel will, as far as possible considering its suitability for later direct disposal, be stored until final disposal is possible. The process of establishing a new long-term storage facility for spent fuel and long-lived waste has been underway for several years, as it is discussed in section G.

Low- and intermediate-level waste, LILW, (mainly short-lived) has been conditioned and stored at Kjeller since the start of the radioactive waste management facility. LILW from the HBWR was routinely transported to Kjeller for treatment. However, with an emerging shortage of storage capacity in the purpose-built buildings at IFE, it became necessary to initiate a process that could yield a permanent solution. A process for a disposal solution for the Norwegian LILW started in 1989. This process resulted in the establishment of the Combined Disposal and Storage Facility for LILW in Himdalen, approximately 26 kilometres south-east of the Kjeller site. The Himdalen facility, taken into service in 1999, consists of four rock caverns with two concrete sarcophaguses in each cavern. The Parliament decided that the facility should contain a storage part where drums containing some small amounts of plutonium should be stored. The final decision on these drums was deferred in order to ease public acceptance of the siting of the facility. The storage part of the facility has the same design as the disposal part, and is situated in one of the sarcophaguses in cavern No. 1. Everything placed in the storage part must be in a disposal-ready form. After the final decision regarding disposal or not with respect to the storage part, the waste packages will either be removed or encased in concrete where they stand.

In 1970, approximately 1,000 drums of LILW were disposed of at the IFE site at Kjeller. The drums were buried in a 4-metre deep trench, which were then covered with clay. When it was decided to build a new disposal facility for LILW, it was also decided to retrieve the waste from the Kjeller site and move it to the new facility. IFE developed the plans and technical solutions for the retrieval process. This waste was excavated and reconditioned in 2002. Today it is disposed of or stored together with the rest of the waste at the Himdalen facility. During the process of retrieving the waste drums, all soil was checked for contamination. Only a small fraction was found to be contaminated. This soil was placed in an ordinary waste drum and stabilized by mixing with concrete. The rest of the soil was filled back into the trenches. Out of the retrieved waste, 166 drums (containing some amount of plutonium) have been placed in the storage part of the Himdalen facility.

All the LILW previously treated, conditioned and stored at IFE has now been moved to Himdalen. The current policy is to dispose of all the LILW (except TE-NORM, high activity disused sealed sources and larger amounts of long-lived waste) at the Himdalen facility. This facility is estimated to have sufficient capacity to accommodate disposal needs until 2030. At that time, a decision will be made whether or not to convert the storage part into a repository.

General clearance and exemption levels are defined in the Regulation on the application of the Pollution Control Act on Radioactive Pollution and Radioactive Waste of 1 November 2010. The clearance levels are in line with the guidance given in the IAEA Safety Standard Series RS-G-1.7 (2004).

The Norwegian authorities are at present considering the future spent fuel and waste management policy. Important aspects are future needs for new nuclear facilities (i.e storage and disposal capacities), optimal use of existing and new facilities, organisational structure, financing and public confidence.

TE-NORM waste produced by the oil industry has been reported earlier by Norway under the Joint Convention, and will be included again in this report. TE-NORM is not handled within the waste treatment system described so far. A separate system, with a special dedicated repository for that purpose, has been designed and has been in operation since 2008. The repository was financed by the main waste generators from the oil industry, primarily the company Statoil ASA. Further details are given in section D.3.2.

C. Scope of Application

Article 3. Scope of application

As a Contracting Party to the Joint Convention, Norway has:

(1) not declared reprocessing as part of Norwegian management of spent fuel;

(2) declared waste that contains only naturally occurring radioactive materials as waste for the purpose of this Convention;

(3) not declared spent fuel or radioactive waste generated within military or defence programmes as spent fuel or radioactive waste for the purpose of this Convention.

D. Inventories and Lists

Article 32 Reporting (2)

D.1 Management facilities for spent nuclear fuel

There are three sites with nuclear facilities in Norway, as seen at the map in Figure D-1 all operated by IFE[1].

The fuel used in the HBWR is low to medium enriched uranium dioxide, mostly 6%. However, for the experimental purposes the enrichment of UO_2 can be achieved up to 20 %. MOX fuel is also part of the experimental program with enrichment up to 10 % fissile Pu to a limited extent.

At the Halden site, the spent fuel is stored in the bunker building outside the reactor hall. Fuel unloaded from the reactor is first cooled for at least 3 months in the fuel pond in the reactor hall before it can be transferred to the storage in the bunker building. The spent fuel will then be stored in the water-filled pond under floor level and later in the dry storage compartment in the bunker building.

Metallic natural uranium fuel remaining from previous core loadings is stored in the dry storage compartment in the bunker building.

The fuel used in JEEP II at Kjeller is 3.5 % enriched. Fuel unloaded from the reactor is first cooled in the water pond in the reactor hall. Later the spent fuel is transferred to the pit storage. The pit storage is a dry storage facility consisting of a concrete block with several storage tubes covered with shielding plugs. The concrete block is located beneath a building specifically designated for loading and unloading of transports of radioactive material.

Spent fuel from the former JEEP I and NORA reactors is stored at Kjeller in a similar storage facility located beneath another building at the site. The storage tubes in this storage location are surrounded mainly by sand instead of concrete; concrete is used only in the bottom and on top of the storage compartment.

[1] IFE is an independent foundation. Activities related to nuclear technology account for about 50% of IFE activity, petroleum technology about 30% and R&D in alternative energy about 20%. Parts of the funding for general research and radioactive waste handling come from various ministries. The HBWR is part of the OECD Halden Reactor Project, which is a co-sponsored research programme involving 18 countries, with the OECD Nuclear Energy Agency as the umbrella organisation. Main research activities at the OECD Halden Reactor Project are fuel and material safety research; and man, technology and organisational (MTO) research. The JEEP II reactor is used for basic research in neutron physics, material science, irradiation of silicon, and production of radioisotopes. IFE has an annual budget of around 500 MNOK (62 M€), of which around 20% is governmental funding. This basis provides the financial resources and staffing to operate the two research reactors and a waste treatment facility. At present, 28 persons are employed at JEEP II, 66 at HBWR and 6 at the waste treatment facility. Total staff employed at IFE number approximately 550 persons.

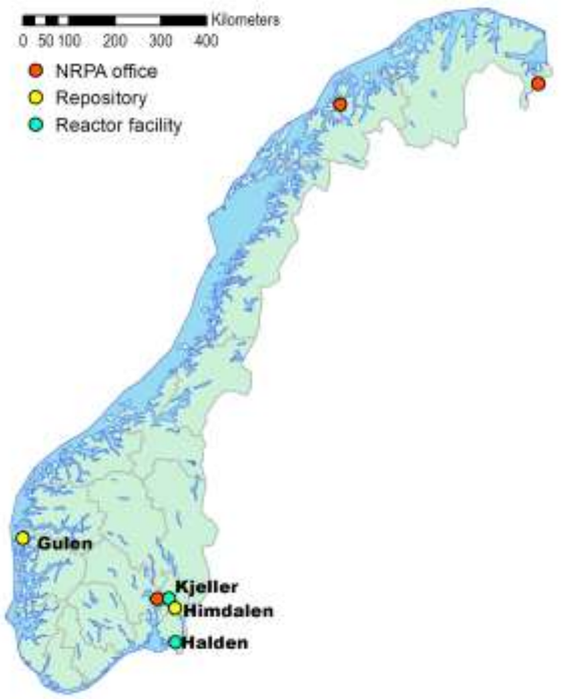


Figure D-1: Map of Norway with relevant sites

Figure D-2: Spent fuel storage facility (JEEP1, NORA)

Figure D-3: Spent fuel storage facility. Kjeller site

D.2 Spent fuel inventory

Type of material	Total IFE-Kjeller (kg)	Total IFE-Halden (kg)	Grand Total (kg)
Enriched uranium	2 168	3 962	6130
Natural uranium	4 377	7 016	11393
Metallic uranium	*3 125*	*6 918*	*10 043*
Depleted uranium	7.1	13,5	20
Thorium	100	12,5	112,5
Plutonium	7.4	14.9	22.3

Table D-1 Inventory of irradiated nuclear material in Norway as of May 2014, Inventory of reactor cores are included. Note that the metallic uranium is given as a part of the natural uranium.

D.3 Radioactive waste management facilities

D.3.1 Radioactive waste management facilities for waste originating from nuclear facilities, research, medicine, disused sealed sources etc.

At the IFE site at Kjeller the following facilities are in operation:

Radioactive Waste Facility (built in 1959)

This is a facility for receiving, sorting, handling, treatment and conditioning of radioactive waste, and is the only facility of this type in Norway. It receives all LILW generated by Norwegian industry, hospitals, universities, research organisations and defence. Treatment of disused smoke detectors takes place in this area as well.

Figure D4: Radioactive waste facility, Kjeller site

Storage Building 1 (built 1965–66)

This building is 434 m^2 in size and is used for the storage of conditioned waste packages.

Storage Building 2 (built 1977–78)

In this building, there is an area (430 m^2) which may be used for storage of conditioned waste packages.

KLDRA Himdalen (built 1997–98)

This is the Combined Disposal and Storage facility for LILW in Himdalen, in Aurskog Høland municipality. It has been in operation since March 1999. The main purpose of the facility is direct disposal of conditioned waste packages. One fourth of the capacity of the facility is today for storage. When the political decision was taken to choose Himdalen for a disposal site it was also decided to allocate a part of the facility for storage where certain waste packages were to be placed. Waste packages placed in the hall for storage are all in “disposal-ready form” and will either be encased in concrete, as is done in the repository part of the facility, or retrieved for disposal at another site.

D.3.2 Repository for NORM waste from the oil and gas industry

In March 2008, the Norwegian Radiation Protection Authority (NRPA) authorised a new repository for radioactive waste from the oil and gas industry on the Norwegian continental shelf.

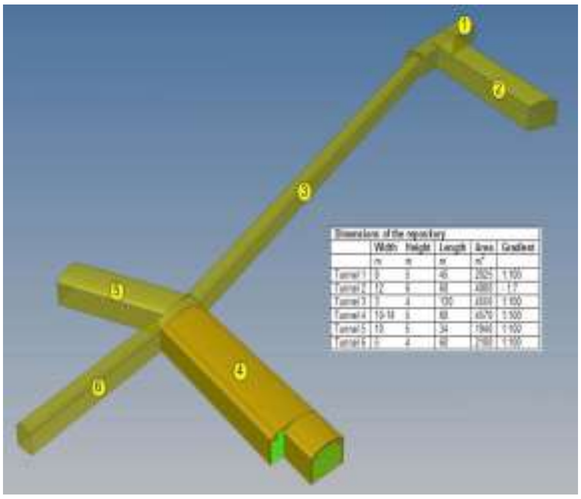


Figure D5: Radioactive waste facility, Kjeller site

The repository is situated within an underground rock formation. It consists of an entry tunnel, a tunnel for waste treatment as well as two tunnels for waste disposal. Treatment consists of dewatering waste, filling void space in the barrels with sand or oil absorbent material and sealing them in a cement matrix. The repository tunnels are to be filled with waste, cemented in concrete mould castings.

There are four barriers to stop the spread of radioactivity from the stored waste. The first barrier consists of the plastic barrel in which the waste is stored. The concrete walls of the permanent mould casting constitute the second barrier whilst the third barrier is the cement around the castings. The final barrier is the surrounding rock formation itself.

For long term safety analyses the repository has been assessed in relation to possible impacts from e.g. flooding, mud slides, earth quakes, breakdown of barrier, and human intrusion,.

NRPA have requested that in addition to the company's own fund for the closure and post closure remediation, there is a guarantee from the Ministry of Petroleum and Energy as a fund in case the operator is not able to operate the repository.

Inventory

The inventory of the repository as of July 2014 is 918 tons of waste, with a total activity of 28 GBq.

The operator has to keep journals over the total activity and activity for Ra-226, Ra.-228 and Pb-210. Parts of the waste in the repository was produced before the repository was authorised and to reduce the amount of legacy waste stored at treatment plants the only information required for this waste was weight and total activity. Therefore only the total activity is listed here.

D.4 Inventory

Norwegian legislation does not specify any criteria for the classification of radioactive waste above exemption limits. Given the long history of radioactive waste management in Norway, the previous IAEA criteria set out in IAEA Safety Series No 111-G.1.1 "Classification of Radioactive Waste" could not be followed exactly for most of the earlier waste, mainly due to the higher than specified content of long-lived alpha-emitting nuclides.

The new classifications set out in IAEA No. GSG-1 "Classification of Radioactive Waste" are more compatible with the waste inventories in Norway, making KLDRA Himdalen more easily classified as a repository for low-level waste.

Historically the following categories were used by IFE: spent nuclear fuel, ion exchange resins, "Some sources" and the other wastes. The waste was segregated according to half-life:

Category I:	≤	1 year
Category II:	>	1 ≤ 30 years
Category III:	>	30 years

Waste packages were sorted according to dose rate levels on the waste drum. For a contact dose rate of >10 mSv/hour, lead shielding is used inside the drums. A smaller drum, of steel with 2 cm of lead on the sides and 3 cm in the bottom and on the top, is placed inside the drum and 6 cm of concrete is poured between the drums. The ion exchange resin is then poured into the inner drum.

The older paper-based archives have now been modernized into an electronic database. This database is managed by the operator IFE. When waste is received, all data are registered – e.g. type of waste, amount and type of radio nuclides, type of container and position in the repository or storage facility. Efforts are currently underway to achieve a more detailed overview of legacy waste, as well as better predictions of upcoming waste.

In Table D-2 is shown the inventory of Norwegian radioactive waste. Note that low and intermediate level waste (LILW) has been divided into short lived (SL) and long lived (LL) isotopes. The distinction between SL and LL is at the half-life of 30 years. High level waste is not currently processed in Norway.

In the early days of the Norwegian nuclear programme, radioactive waste was defined by

“Gross alpha” and “Gross beta”. Later, amounts of uranium “U”, plutonium “Pu”, fission products “FP” and mixed fission products “MFP” were used. None of these categories can easily be converted to a level of radioactivity (MBq) using present classification system. It is difficult to evaluate the exact activity concentrations in the former waste because of problems in estimating decay times. It has been decided to retain the old terms in connection with earlier waste. In 3 both old and new categories are used.

The remaining solutions of uranium containing some plutonium and fission products from the decommissioned reprocessing test facility were until 2006 stored in stainless steel tanks in the radioactive waste treatment plant, but have been completely removed and are now solidified as yellow cake stored in steel drums.

Approximately 160 – 170 drum equivalents of waste are generated each year. Out of this 80 are from the activities at the IFE’s sites and 80 – 90 from other and external generators.

D.5 Decommissioning

No nuclear facilities are in the process of being decommissioned in Norway. However some clean-up after decommissioning of the pilot reprocessing plant at the Kjeller site are being performed.

	Himdalen Repository (MBq)	Himdalen Storage (MBq)	IFE LILW-SL (MBq)	IFE LILW-LL (MBq)
Ac-227	1760			
Gross alpha*	4447			
Am-241	5 789155			
Ba-133	10265			
C-14	51920			
Cl-36	47			
Cm-244	4268			
Co-60	5 796 800	986		
Cs-137	49 328 548	150 138		
Eu-152	2277			
Eu--154	1791			
H-3	104209216			
Hg-203	17			
I-129	39			
Kr-85	228514			
MFP*	103823			
Ni-63	78218			
Pu-238	258861			
Pu-239	2270			
Ra-226	5450			167 992
Ra-228	229			
Sr-90	1110524	143 758		
Tc-99	384			
Th-232	781			
U,Pu,FP*	2 497 894			
U-238	927	166		
Pu (mg)**	20 925 mg	35 026 mg		460mg
Total no. of 220-litre drums	5402	1 66	50***	30***

* = Historical categories, see above. Gross alpha includes also Pu. MFP = Mixed Fission Products

** Historical categorisation, still in use. Amounts of Plutonium are given in mg, and include Pu^{239} and Pu^{240}.

*** Under treatment, no specific activity can be given.

Table D-3 Inventory of Norwegian radioactive waste as of December 2013

E. Legislative and Regulatory Systems

Article 18. Implementing measures

Article 19. Legislative and regulatory framework

Norway is a constitutional monarchy formally headed by the King as head of State and the Prime Minister as appointed head of Government. The Prime Minister is supported by a council (cabinet), appointed by him with the approval of the Storting (the Norwegian Parliament). Statutes are passed by the Storting and sanctioned by the King in Council. Regulations, directives and orders and certain licenses are generally adopted by the King in Council or the Ministries upon the advice of ministries and directorates of the Ministries.

NRPA is the Government's competent authority on matters concerning radiation protection and nuclear safety and security. It is organised as a directorate under the Ministry of Health and Care Services, from which it primarily receives its funding. NRPA is a directorate also under the Ministry of Climate and Environment with respect to releases to the environment and waste from nuclear and non-nuclear industries, and under the Ministry of Foreign Affairs with respect to implementing safety measures in Russia under the Action Plan for Nuclear Safety in North West Russia. NRPA also provides assistance and advice to other ministries on matters related to nuclear radiation protection, radioactive waste management, nuclear safety and security.

All nuclear activities, including transboundary movements, are regulated by three legal instruments: the Act on Nuclear Energy Activities of 12 May 1972, the Act on Radiation Protection and Use of Radiation of 12 May 2000, and the Act of 13 March 1981 Concerning Protection against Pollution and Concerning Waste.

E.1 Act on Nuclear Energy Activities of 12 May 1972

The Act on Nuclear Energy Activities regulates the licensing regime for nuclear facilities, general requirements for licences, inspection regime and the legal basis for the regulatory body. Chapter III of the Act establishes the liability regime according to the Paris Convention of 29 July 1960 as amended and related international legal instruments. The final part of the Act regulates confidentiality and penalties in case of non-compliance. The Act does not specifically mention license to decommissioning of nuclear activities. Pursuant to the Act, following four regulations have been issued:

- Regulations of 2 November 1984 on the Physical Protection of Nuclear Material.
- Regulations of 15 November 1985 on Exemption from the Act on Atomic Energy Activity for Small Amounts of Nuclear Material.
- Regulations of 12 May 2000 on Possession, Transfer and Transportation of Nuclear Material and Dual-use Equipment.
- Regulations of 14 December 2001 on Financial Compensation after Nuclear Accidents.

The regulations of 2 November 1984 establish requirements for the physical protection of nuclear material and nuclear facilities. The regulations implement the obligations of the Convention of the Physical Protection of Nuclear Material. Last revision entered into force 1 January 2008.

The regulations of 15 November 1985 exempt small amounts of nuclear material from Chapter III of the Act and thus from the liability regime.

The regulations of 12 May 2000 deal with the control and accountancy of nuclear material, as required in the Additional Protocol to the Safeguards Agreement between Norway and the IAEA.

The regulations of 14 December 2001 stipulates how Contracting Parties to the Vienna Convention of 21 May 1963, Contracting Parties to the Joint Protocol of 21 September 1988 and Hong Kong shall be considered in connection to Norwegian legislation on nuclear liability. They also regulate how nuclear accidents in a non-party state shall be considered in connection with the Norwegian legislation.

Additionally, there is the Royal Decree of 28 November 2008 on "Renewed Licence for Operation of Nuclear Installations pursuant to the Act on Nuclear Energy Activities" and the Royal Decree of 25 April 2008 on "Renewed Licence for Operation of Combined Storage and Repository for Low and Intermediate Level Waste in Himdalen", issued to the Institute for Energy Technology (IFE). The main basis for the licences are the SARs for the two reactors and related auxiliary facilities as well as the SAR for the Himdalen Combined Storage and Repository submitted with the application for renewal of the licenses, and the recommendations provided by the NRPA in the evaluation of safety as prescribed in the legislative system. Under the Atomic energy Act public consultation is not required by the law, but it is practiced by the NRPA as part of licensing process.

E.2 Act on Radiation Protection and Use of Radiation of 12 May 2000

The Act on Radiation Protection and Use of Radiation of 12 May 2000 constitutes the legal basis for regulating the use of ionising and non-ionising radiation, radiation protection requirements, medical use of radiation and contingency planning. The Act itself establishes the framework, which is spelt out in further detail by the regulations. Pursuant to the Act, two regulations have been adopted:

- Regulation on Radiation Protection and Use of Radiation of 29 October 2010.
- Regulation on the Applicability of the Act on Radiation Protection and Use of Radiation on Svalbard and Jan Mayen of 9 May 2003.
- Furthermore, Regulation relating to Systematic Health, Environmental and Safety Activities in Enterprises of 6 December 1996 is adopted pursuant to several acts concerning health and safety issues, among them the Radiation Protection Act.

E.3 Act of 13 March 1981 Concerning Protection against Pollution and Concerning Waste

The Act of 13 March 1981 Concerning Protection against Pollution and Concerning Waste was established for the purpose of preventing and reducing harm and nuisance from pollution. This is reflected in the main rule of the act, which says that pollution is forbidden, unless it is specifically permitted by law, regulations or individual permits. The act shall secure a satisfactory environmental quality based on a balance of interests, which includes costs associated with any measures and other economic considerations. Pursuant to the Act, three regulations concerning radioactive pollution and radioactive waste have been issued:

- Regulation on the application of the Pollution Control Act on Radioactive Pollution and Radioactive Waste of 1 November 2010
- Regulation on the Recycling of Waste of 1 June 2004
- Regulation on Pollution control of 1 June 2004.

The regulation of 1 November 2010 defines what radioactive pollution and radioactive waste is.

The Regulation on the Recycling of Waste establishes requirements for waste in general, chapter 16 deals with radioactive waste.

The Regulation on Pollution control defines procedures for applications for permits and establishes administrative provision for radioactive pollution and waste.

The Royal Decree of 17 February 2006 establishes the organisation of the emergency preparedness system in Norway, under article 25.

According to Act of 27 June 2008 No. 71 on Planning and Building Activities with specific regulations concerning impact assessments of 1 April 2005 No. 276, nuclear power plants and other nuclear reactors, plants for the handling of irradiated nuclear fuel, plants for production or enrichment of nuclear fuel, and installations for disposal of radioactive waste and storage facilities where radioactive waste is stored for a period of more than 10 years shall always be subjected to an impact assessment. When planning an installation for collection, handling and storing of radioactive waste for a period of less than 10 years, one should consider carrying out an impact assessment. The decision on whether an impact assessment should be carried out is to be taken by the competent authority.

Neither the Acts nor the regulations are very specific in regulating spent fuel and waste issues. All details will have to be regulated through requirements and guidelines associated with licences and approvals, with these being handled on a case-by-case basis.

Article 20. Regulatory body

As defined in the Act on Nuclear Energy Activities and Act on Radiation Protection and Use of Radiation, the regulatory body is NRPA. NRPA is also regulatory body for the Act Concerning Protection against Pollution and Concerning Waste in matters concerning radioactive pollution and radioactive waste as delegated by the Ministry of the Environment 30. December 2010. NRPA regulates matters concerning nuclear safety and security, nuclear emergency preparedness and radiation protection including radioactive waste and spent fuel management.

The builder and owner of the combined disposal and storage facility in Himdalen is Statsbygg (Directorate of Public Construction and Property), which is organised under the Ministry of Modernisation. All organisations receive their funding from the respective ministries on a yearly basis following the Norwegian State Budget.

NRPA has a total staff of 130 persons and a total annual budget of approximately 25000 MNOK. NRPA is organised in four departments, which are further divided into specialised sections:

- *Department for Radiation Applications*
- *Department for Nuclear Safety and Environmental Radioactivity*
- *Department for Monitoring and Research*
- *Department for Planning and Administration*

The Department for Nuclear Safety and Environmental Radioactivity deals with the safety and security of Norway’s nuclear facilities, licencing of radioactive waste management and discharges. It also handles licensing of shipments of nuclear material and issues approval certificates for transport packages.

NRPA handles applications for licences and renewal of licences for the operation of nuclear facilities. An application for a license to construct or operate a nuclear facility shall be sent to the Ministry of Health and Care Services, whereupon NRPA as the competent authority will be requested by the Ministry to review the application. If someone were to send an application for the construction of a nuclear reactor for commercial purposes the application should be sent to the Ministry of Petroleum and Energy. NRPA is responsible for proposing criteria and requirements and may also request additional investigations or information from the applicant. NRPA will then prepare a report for the Ministry with the result of the review of the application (safety reports, etc). In this report NRPA will specify any further requirements that the applicant should fulfil, and will give its recommendation to the Ministry for the approval/rejection of the application. On this basis, the Ministry will prepare the documentation for a decision by the Government (actually by the King in Council).

Once the application is approved, a licence will be granted by the Government. NRPA will carry out regular inspections and audits to ensure that licence requirements are fulfilled and complied with. NRPA is also responsible for issuing licences for radioactive waste management and discharges for all three nuclear facilities in Norway. NRPA is responsible for the State System of Accountancy and Control under the Safeguards Agreement between Norway and the IAEA. NRPA is fully authorized through legislation to enter a nuclear installation and surrounding area, at any time, and to request the information necessary for the purpose of the inspection. To enable the requisite inspections to be carried out after operational interruptions or accidents, licensees shall provide reports to NRPA. Inspections are provided by NRPA also in response to the operator's request in cases of any intended changes in construction, operation or management which constitute a departure from approved conditions. NRPA inspections often focus on a specific activity or practise. For example in connection with the retrieval of the waste drums, several inspections were performed. The Himdalen facility is normally inspected once or twice each year.

NRPA may at any time independently communicate regulatory requirements, decisions and opinions to the public. It will, as appropriate, liaise with the regulatory bodies of other countries and with international organisations for cooperation and exchange of regulatory information. The IAEA Safety Standards Series are followed and implemented to the extent that they are applicable.

F. Other General Safety Provisions

Article 21. Responsibility of the licence holder

IFE is the licence holder for ownership and operation of Norway's two research reactors as well as for the operation of the combined disposal and storage facility in Himdalen. It is the responsibility of IFE to ensure the highest possible levels of the safety for all its nuclear facilities during operation, decommissioning and closure of facilities. The safety levels shall be in accordance with the licence requirements and appropriate international standards. A licence for operation is normally granted for specific time period. At the end of a licence period the operator must apply for a new licence. New/fully updated SARs shall be sent to the Ministry with the licence renewal application. The current licence for the IFE's nuclear facilities expires:

- JEEP-II reactor Kjeller 31 December 2018,
- HBWR reactor Halden – 31 December 2024, provided the license is granted.
- Combined Disposal and Storage Facility – 28 April 2028.

NRPA also issues licenses for radioactive waste management and discharges to IFE, requiring IFE to employ the best available technology to reduce discharges to levels as low as reasonably achievable. The licensee is also responsible for providing the necessary financial and human resources for maintaining safety and radiation protection at an appropriate level.

Article 22. Human and financial resources

Human and financial resources for NRPA are not explicitly covered by legislation. However the Norwegian regulatory body was established several decades ago, and today precedent serves as the basis for its annual budget. Most non-administrative staff members at NRPA hold higher university degrees. All new employees are required to complete an internal training course. Training is given by senior staff, and NRPA employees attend courses and/or seminars as needed. For certain specific tasks, external advisers or consultants may be contracted.

IFE provides the financial resources and staff to operate Norway's nuclear facilities (reactors, storage facilities, radioactive waste treatment plant) and the combined disposal and storage facility. It also organises the necessary training and refresher training of its personnel and pays an annual inspection fee to cover the most relevant functions in NRPA. The role of NRPA is to supervise that the resources and training/refresher training provided by IFE are appropriate. The Act on Nuclear Energy Activities authorises NRPA to impose sanctions on IFE in the event that safety standards are not maintained at an acceptable level.

No specific sanction criteria have been established. All NRPA requirements can be appealed to Ministry of Health and Care Services, or the Ministry of Climate and Environment in case of releases to the environment; this is a general right in the Norwegian civil service system. NRPA may at any time withdraw the permit to operate (for all or some facilities) as necessary if sanctions are not followed or safety standards are not adequate. NRPA has the authority to impose fines, either as a one-time sum or on a per diem basis if its sanctions are not followed. In case of criminal activities, NRPA is to report to the police.

To the extent possible, the structure of the system in Norway follows the IAEA Safety Requirements.

Article 23. Quality assurance (QA)

IFE has established a system for quality assurance to cover its research reactors and waste facilities, and provides for all aspects of operating a nuclear facility. This QA system is supervised by the regulatory body (NRPA). The licensee must also fulfil Norwegian quality assurance requirements as to health, working environment and safety, as specified in other regulations.

IFEs QA program has been written in the QA handbook and is based on the ISO 9001 standards and IAEA guidelines. . The QA handbook also draws the policy guidelines of the IFE, guidelines for setting the goals of different departments at different levels.

The quality assurance programme for the combined disposal and storage facility in Himdalen based on the principles set out in the IAEA Safety Series Requirement No WS-R-1.

IFE is responsible for implementing and maintaining a quality system according to the licence granted by the Norwegian Government. IFE performs self-assessment and internal audits of the system, whereas NRPA perform audits to verify that IFE procedures and its quality management system comply with the requirements specified in the licence and in laws and regulations. NRPA evaluation system follows the principles set out in the IAEA Safety Standards Series Requirements No. GS-R-1.

A new process oriented quality assurance system for the NRPA with written procedures for licensing and inspection activities is currently under development.

Article 24. Operational radiation protection

The national system for radiation-dose control for workers is based on the regulatory requirements that all workers who may receive more than 1 mSv per year are required to wear personal dosimeters. Radiation-dose control for the public is based on the regulatory requirement that practices must limit exposure, so that no individual may receive doses exceeding 0.25 mSv per year.

Optimisation of radiation protection is a general regulatory requirement in Norwegian legislation. In addition, provision is made for operational optimisation through several guidelines detailing specific technical requirements concerning shielding, work practices, protection devices, etc.

The revised regulations of the radiation protection (1 January 2011) are based on international standards like the IAEA Safety Standards GSR part 3., dose limits from ICRP 103, and the general requirements that radiation sources and equipment shall be made according to the latest version of applicable ISO and IEC standards. The radiation protection regulations contain a general requirement that licensees must possess adequate radiation protection expertise. This general requirement is further elaborated in several guidelines, where more specific training requirements in the various fields of work are given.

According to the 2000 Act on Radiation Protection and Use of Radiation, the operator shall report radiation doses sustained by each worker annually to NRPA. These doses must be kept below 20 mSv/y (adaption of the ICRP 103 for each worker). The facility operator shall register the doses. In general, annual radiation doses should be below 20 mSv/y. Pregnant workers have a dose limit of 1 mSv for the remainder of the pregnancy, i.e. after the pregnancy has been diagnosed. There are no particular dose limits for women of childbearing age.

IFE has developed a system of work planning to keep staff radiation doses as low as is reasonably achievable, especially during maintenance work. This has led to improvements in general radiation protection at the facility as well as lower doses sustained by staff.

The operational limits and conditions for IFE’s nuclear facilities and discharges are specified in licences in order to ensure that discharges are limited. Furthermore, specific measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment. The existing discharge permits specifies that, with respect to the risk of radiation exposure to population groups as a consequence of discharges, the maximum permitted doses to the population group most likely to be exposed must fall below 1 µSv/year for liquid discharges and below 100 µSv/year in the case of discharges to the air, in which the dose contribution from iodine isotopes shall be below 10 µSv/year. This condition applies to the site at Kjeller and that in Halden separately. In addition nuclei specific discharge limits have been established for the Kjeller and Halden site separately.

A separate set of criteria has been established for the facility in Himdalen. No continuous radioactive discharges are permitted from the facility during operation, and the resultant dose to the critical population group from any activity releases from the facility after closure, shall not exceed 1 µSv/year.

IFE submits annual reports of environmental and discharge information to the regulatory body (NRPA). Information concerning discharges is available to the public on the IFE website (http://www.ife.no).

Article 25. Emergency preparedness

Emergency planning in Norway is based upon the principles of responsibility, proximity, similarity and co-operation. This implies that

- The organisation which holds responsibility in a normal situation also has the responsibility when extraordinary situations occur.
- Any crises shall be dealt with at the lowest possible level.
- The organization which is in daily operation shall to the greatest possible degree be similar to the organization which is planned for in a crisis situation.
- In a crisis situation, the involved organizations on all administrative levels shall co-operate.

The Norwegian nuclear and radiological emergency response system complies with the general principles for emergency planning. The main element in the response organisation is the Crisis Committee, headed by the Director

General at the Norwegian Radiation Protection Authority.

Overview of Preparedness Elements

1. General

In general, the licensee is responsible for organising plans for on-site emergency preparedness and response. IFE has adapted plans for each site, and these are exercised regularly. The off-site response is planned by the local police authorities and coordinated with the Crisis Committee (see below).

Based on the Royal Decree 23 August 2013, the Government has established a national response organisation made up of representatives from the following entities:

- the Crisis Committee for Nuclear Preparedness (CCNP);
- the Advisors to the Crisis Committee;
- the Secretariat for the Crisis Committee (NRPA);
- the regional emergency organisations.

The ministries are responsible for emergency preparedness within their area of competence. In the normal situation, the ministries co-operates in the Ministerial Coordination Committee.

The Ministry of Health and Care Services head this Committee. In any event, co-ordination on the ministerial level is taken care of by the responsible ministry through the Crisis Council.

2. The Crisis Committee and the Advisers

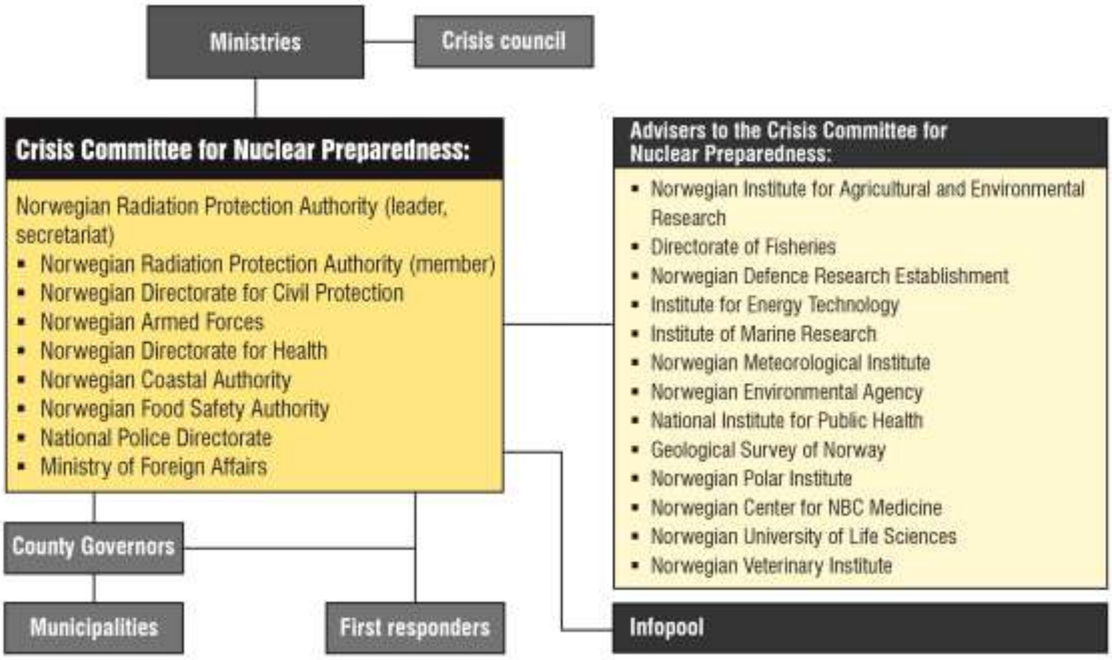
The Crisis Committee for Emergency Preparedness is made up of representatives of the following institutions:

- Norwegian Radiation Protection Authority (head and member);
- Directorate for Civil Protection and Emergency Planning;
- Norwegian Armed Forces;
- Norwegian Directorate for Health;
- Norwegian Costal Authority;
- Norwegian Food Safety Authority;
- National Police Directorate and
- Ministry of Foreign Affairs;

The Advisers to the Crisis Committee are representatives from organisations and institutions with expertise and responsibility required in an emergency organisation both with regards to the management of nuclear accident situations, and for further development and maintenance of emergency preparedness.

The Crisis Committee is responsible for implementing countermeasures in case of a nuclear event representing a potential threat to Norway, or Norwegian citizens and interests. The Committee can:

- Order the securing of areas that are or could be heavily contaminated (e.g limiting access and traffic, securing and removing radioactive fragments);
- Order emergency evacuations of local communities;
- Order short term measures/restrictions regarding food production;
- Order/advice on the decontamination of contaminated people;
- Provide advice to shelter;
- Provide advice on thyroid blocking;
- Provide dietary advice and
- Provide advice on other consequence reducing measures, including measures to limit contamination of the environment.



Figur F1: Overview of the structure of the Crisis Committee

3. The Secretariat for the Crisis Committee

The Secretariat for the Crisis Committee (NRPA) is responsible, *inter alia*, for alerting the Nuclear Emergency Organisation, and relevant international bodies. The Secretariat organises a 24/7 Officer on Duty Service. NRPA is NWP and NCA according to EPR-IEComm.

The Secretariat also operates the emergency response systems and facilities for the Crisis Committee and assists the work in the Crisis committee and the participating organisations.

4. The Regional Emergency Organizations

The Country Governors direct the regional emergency organisations. They contribute to a co-ordinated regional and local emergency preparedness and response. Their responsibilities include co-ordination of planning and initiating countermeasures in accordance with local needs and demands, and they continuously liaise with the Crisis Committee.

5. Exercises

NRPA contributes to exercise activity on many levels of the response organisation. In previous years there has been a major focus on enhancing the competence of nuclear and radiological response on the regional level. In 2013, NRPA participated in a Nordic-Baltic exercise (NB8). In addition, a large exercise was arranged in co-operation with the Ministry of Foreign Affairs. NRPA participates in regular exercises among the Nordic countries: i.e. the REFOX exercise in Sweden in September 2012 and notification exercises. NRPA also participates in most of the IAEA Convex exercises. These exercises give valuable training opportunities for the NRPA staff and the Crisis Committee.

Norwegian emergency response arrangements are exercised on the national, regional, and local levels. Relevant scenarios include: satellite crash, nuclear submarine accidents, nuclear ice-breaker accidents, transport accidents, dirty bombs, etc. Orphan sources are found every now and then, helping maintaining a high awareness of such incidents. There is no predefined regularity in these exercises.

IFE has adapted emergency plans for each site, and exercises these regularly.

Reference Scenarios

The Crisis Committee has recommended six dimensioning scenarios as a basis for the national emergency planning:

1. large airborne release from foreign facility;
2. large airborne release from domestic facility;
3. local event with mobile source;
4. local event that develops over time;
5. release to marine environment;
6. a serious accident abroad that can affect Norwegian interests, but not territory.

These scenarios have been approved at a ministerial level. The dimensioning scenarios are meant to assist the Crisis Committee in prioritising, meet the needs, and plan for a best possible emergency preparedness. Dimensioning scenarios take into account the consequences to life, health, environment, society, and economy.

Emergency Preparedness and Response and Post-Accident Management (Off-Site)

NRPA has conducted an evaluation of its own performance during the event in Fukushima and will take due note of the findings. The review includes a survey among main actors in the media, analysing their interaction with the NRPA, and the information they received during the crisis. In addition, a survey among the general public was conducted. The conclusions were largely that the NRPA was able to manage the crisis to the satisfaction of the concerned stakeholders; the media, governmental bodies, and the public.

The results of the stress testing of the Norwegian facilities show that there are no real changes in the threat assessment. Major changes in the emergency organisation are thus not necessary. However, the lessons learned from the crisis will be taken into account in the future work to enhance the effectiveness of the emergency organisation.

Severe Accident Management and Recovery (On-Site)

The analysis of the consequences of the most severe accident has also been reviewed. This is a loss of coolant accident with simultaneous loss of several emergency systems. Such an event will lead to releases to the environment surrounding the reactor facility. The calculations have so far shown doses to members of the public below the IAEA recommended guidelines for emergency situations. These results were confirmed in the present review.

The plans for emergency preparedness are based on scenarios that are described in the Safety Reports. IFE concludes that there is no need for any major changes as a result of the analysis.

However, it was identified that in a complete blackout situation, much of the communication that relies on electronic means, like phone, fax and mail, could become unavailable. This also includes difficulties in getting information on the status of the reactors in case of an emergency. IFE will make a further assessment of such a situation, and will consider holding exercises without the use of the normal electronic communication infrastructure. It was also identified a need to review the type, number and location of equipment for such emergency situations.

NRPA has taken note of the information given by IFE, and is awaiting the final results.

Overview of Response Elements

1. Standing Preparedness

Norway operates a national automatic gamma monitoring network, consisting of 34 continuously run stations. One station is operated by the Norwegian Armed Forces; however, NRPA has access to the data. A mobile monitoring unit is also available. The data acquired is directly available to the competent authority, the emergency response organisation, and the public via radnett.nrpa.no. In addition, Norway has 5 high volume air samplers, where 4 have alarm capabilities with GM-counters on top of the filters.

Norway exchange monitoring data with neighboring countries through a binding agreement administered by the Council of the Baltic Sea States (CBSS). Secondly, Norway exchanges data with the European Commission (EC) through the EURDEP platform in accordance with a MoU between NRPA and EC.

Norway has established bilateral agreements on early notification with Finland, Germany, Lithuania, the Netherlands, Poland, Russia, Sweden, Ukraine, and United Kingdom. The agreements differ slightly in wording, but are based on the IAEA Convention of Early Notification from 1986. These agreements will ensure an early notification if an event occurs at a facility covered by the agreements. Norway is in a process to join ECURIE.

2. Measurements and prognosis

The national response organisation has access to a wide variety of monitoring equipment and prognosis systems. Important examples are given below:

- Areal monitoring systems are operated by the Armed Forces, Norwegian Geological Survey and NRPA. There is an ongoing work to establish robustness in response.
- Handheld equipment is available at NRPA (three locations), in the Civil Defence and in the Armed Forces. The NRPA resources are planned to equip three equal, advanced teams. The Civil Defence has a number of dose rate monitors and can also collect samples, and they exercise regularly.
- Laboratory measurement systems are available at NRPA (three locations) and a few other organisations. There is an ongoing work to re-establish a measurement system for foodstuff and drinking water for emergency response. The approach is to establish a system of less advanced laboratories and improve the emergency response capacities in the advanced laboratories.
- Long range dispersion modelling has been an important priority for the response organisation and the Norwegian Meteorological Institute and NRPA are working closely together. NRPA is using the ARGOS system but other modelling tools have also been taken into use.

3. Providing information

The Crisis Committee can involve a national pool of information people to assist in disseminating information in an event. A robust webpage[2] is available for all authorities in all kinds of events to provide information to the public.

Article 26. Decommissioning

As part of the licensing requirements, in December 2006 IFE provided a plan for the decommissioning of its facilities. The plan was revised in 2007, 2010, and 2012, specifying decommission of the facilities to “green field”. These decommissioning plans follow the recommendations of the IAEA Safety Standards Series No. WS-G-2.1 at the level of “ongoing planning”. Important factors in the current evaluation of the decommissioning plans are financing, organisational matters, in particular related to future waste handling in Norway, how to maintain critical competence throughout the dismantling work and maintaining technology and infrastructure of historical and cultural importance. The Norwegian government has recently agreed in principle to partly finance the decommissioning of the nuclear facilities.

[2] www.kriseinfo.no

G. Safety of Spent Fuel Management

Article 4. General safety requirements

Norwegian general safety requirements for the safety of spent fuel management follow the IAEA recommendations in the field. IFE is responsible for the management of spent fuel from the two reactors. The principles and requirements are detailed in the safety analysis reports for IFE's management programme. These safety analysis reports constitute an integral part of IFE's licence as granted by the Norwegian government; hence the requirements set out in the safety analysis reports are mandatory. The principles stated in subsections (i) to (vii) of article 4 are all adequately addressed in the safety analysis reports.

Article 5. Existing facilities

IFE has more than 50 years of experience in handling and storing spent fuel. To date, there have been no incidents at Norwegian facilities with respect to these activities. Spent fuel from the reactors is stored at the reactor sites. At the HBWR, spent fuel is stored in a bunker building outside the reactor hall. The metallic natural uranium spent fuel is stored inside the bunker within a dry storage compartment; the rest, which is oxide fuel, is partly kept in the dry storage, but most of the fuel is stored in a pool underneath the floor. There are also storage pools within the reactor hall. Water in the pools is continuously monitored. IFE has storage capacity for at least another 10 years or more of operation.

At Kjeller, the spent fuel from the JEEP II reactor has been placed in a dry storage facility consisting of a concrete block with several storage tubes covered by shielding plugs. The fuel stored here has a cooling period of at least 90 days and does not require further cooling beyond that provided by natural air circulation in the storage tubes. The concrete block is placed under a building specially designated for loading and unloading transport of radioactive material. Between removal from the reactor and emplacement in dry storage, the fuel is cooled in water pools in the reactor hall.

As indicated before that "stress tests" have been conducted to all IFE's nuclear facilities, including spent fuel pits at Halden and at Kjeller reactor sites. For the HBWR, the fuel is stored in fuel pits in the reactor hall. The pipe inlets and outlets are at the top of the pits, and thus a pipe break will not result in leakage of water. If a blackout occurs with a full core loading in the fuel pit, the calculations show that the fuel may be completely uncovered within 7.5 hours. However, the heat generation from the fuel normally stored in the pit is about 30% of a full core loading of spent fuel. The calculations show that the cladding temperature will not be high enough to cause hydrogen production. As an extra precautionary measure, an additional water supply was installed in the first half of 2012.

Spent fuel from the former JEEP I (1951–1967) and NORA (1961–1968) reactors is stored in a similar storage facility under another building at the site. The storage tubes in this facility are surrounded mainly by sand as opposed to concrete; concrete is used only in the bottom and on top of the storage. On the basis "Stranden committee" recommendations IFE conducted number of tests on a few fuel elements of the JEEP-I reactor to control the status of the metallic uranium fuel in 2012. The results from these investigations indicated the presence of uranium hydride. This was an indication of the presence of moisture in the dry storage of the spent fuel. The presence of the corrosion in other fuel elements was observed during these investigations. These findings have resulted in a limited handling of the fuel from JEEP-1 and HBWR for testing purpose. IFE established an expert group to investigate the situation completely. Recently, the expert group has submitted its recommendations, which includes the following:

- A complete investigation of the first fuel loadings of JEEP-I and HBWR is required

- JEEP-I fuel should be given priority over HBWR fuel because of the presence of the uranium hydride and non-optimal storing conditions for the fuel.
- Inspection of JEEP-I fuel should be done in-situ
- There is a need for new inspection and handling facility at IFE Kjeller.
- Two new transportation casks are required to transport a) the spent fuel from JEEP-I storage well to the inspection site, and b) transport from HBWR to IFE Kjeller for inspection.

NRPA is following the activity closely and have conducted the inspections in this regard.

Article 6. Siting of proposed facilities

No definitive proposals have been made for the spent fuel management facility in Norway at present. However, the Government recently has appointed a technical committee to get recommendations on the interim storage for the spent fuel and the decommissioning liabilities of the Norwegian nuclear facilities in future. In a previously appointed “Stranden committee” by the Government, recommendations were made for the siting of a future facility for the storage of spent fuel and long-lived waste. The committee’s favoured solution is that a new facility for storage of transportable storage casks is built in a rock cavern at an existing nuclear site, subsequently that a new rock cavern facility is constructed in the south-east of Norway.

Article 7. Design and construction of facilities

Construction of new nuclear facilities would be the result of a well-defined process following domestic legislation as well as recommendations made by the IAEA and other international agencies. In developing the criteria, the IAEA Safety Standards Series Requirements and guidelines would be an important and integral part. All steps as prescribed in Articles 6 and 7 would then be followed, and other relevant Contracting Parties to the Convention would be consulted.

Article 8. Assessment of safety of facilities

Before construction of a spent fuel management facility, an impact assessment is required. A licence for construction is also required, to be granted on the basis of a systematic safety assessment. It is the builder/owner of the facility that is responsible for carrying out the assessments. The authorities then review the safety reports in connection with the licence application. Plans for later decommissioning of the facility are required as a part of the assessments.

Before the facility can be commissioned, the operator must apply for an operating licence. The application must describe the systems necessary for safe operation and how the authorities’ requirements will be fulfilled in safety report(s).

Before the start of operation, updated and detailed versions of the safety assessments must be prepared, reviewed and approved by the authorities. Permission to start the operation of the facility can be granted by NRPA only after all documentation is in place and approved.

Article 9. Operation of facilities

The safety assessment of facilities is guided by the relevant IAEA recommendations. Safety analysis reports are updated on a regular basis, and reported to the regulatory body every five years. In line with the terms of the current licence, an impact assessment for the IFE’s nuclear facilities has been conducted according to the Planning and Building Act. NRPA is the competent authority for this process. The notification, including a proposal for a study programme, has been subjected to a public inquiry. NRPA has determined the study programme after comments from the Ministry of the Environment. IFE delivered its impact assessment report in December 2004, and the report was the subject of a public hearing. The impact assessment was expanded with analyses of beyond design base accidents in 2006. The final impact assessment was approved by the NRPA in 2007.

At present, the operation and maintenance of the spent fuel facilities is considered part of the operation of the reactor plants, and are regulated through the operating licence of the IFE nuclear facilities. The licence has been granted on the basis of the safety assessments. NRPA performs inspections to ensure that operation, monitoring and maintenance are in accordance with the requirements.

The radiation-dose limit to the public for the operation of such facilities is a part of the total limit for any discharge from reactor sites. These dose limits set targets for permissible doses from the operation of the facilities, and the fulfilment of these targets is documented in the safety analysis reports. If and when another facility is put into operation, the operating procedures will become a part of the licence for that facility. Any significant incidents must be directly reported, without undue delay to NRPA. Decommissioning plans will be developed during the licence period. In the case of a new facility plans for decommissioning would be required at the planning stage.

Article 10. Disposal of spent fuel

A portion of Norway’s spent nuclear fuel was reprocessed in 1969 in Belgium. This fuel originated from HBWR. In the table 4.1 is shown the total inventory of the spent fuel material. The current disposal plans for the present and future spent fuel inventory exists only as recommendations from the government proposed committees, and as such no concrete plans have been made. The favoured option based on these committees’ recommendations is the direct geological disposal of the fuel which is suitable for such disposal route.

A governmentally appointed committee has made recommendations for a further strategy regarding the management of spent fuel (NOU 2001:30). This committee recommended the establishment of a central (long-term) storage facility for spent fuel aimed at storage for a timeframe of some 40 to 60 years. Thereafter the fuel should be transferred to a repository, which should be operationally ready by this time. To prepare a solid basis for the construction of such a repository, the committee recommended that further research be undertaken in the field of rock disposal of spent fuel, e.g. concerning borehole technologies. The committee also suggested that the operation of such a facility should be transferred to a new waste management organisation, which could also coordinate the research and public information activities. No suggestions were made as to where the new storage facility and/or disposal facility should be located.

As a first follow-up of the committee’s recommendations, a study was performed in 2004 on possible technological solutions for a new central storage facility for spent fuel and long-lived waste. The study also offered more detailed recommendations concerning actions needed in order to establish a new central storage facility. The favoured option based on these recommendations is the direct geological disposal of fuel that is suitable for such route, i.e., uranium dioxide fuel inside zirconium cladding. Metallic uranium with aluminium cladding is thought unstable for the direct disposal and will needed to be stabilized before long term storage and subsequent disposal.

Two second follow-up committees, based on the first committee’s recommendations, were established by the Government in 2009. The first committee, called the technical committee, presented their results in 2010. Their mandate was to suggest solutions for stabilising metallic uranium and/or aluminium clad fuel for storage and final disposal. Such fuel represents a large portion of Norwegian spent nuclear fuel. Based on technical and economic considerations, the committee’s recommendation was that the fuel in question should be reprocessed at existing reprocessing facilities abroad.

The second committee, called the “Stranden committee”, represented their findings in NOU 2011:2. Their mandate was to suggest suitable sites for a long term storage facility for spent nuclear fuel and long lived waste as detailed under article 6 *Siting of proposed facilities.*

The Ministry of Trade, Industry and Fisheries (MTIF) has recently called a concept evaluation to get recommendations on the following two processes in parallel:

1. Interim storage for spent fuel including treatment of metallic fuel
    a. Treatment before storage
    b. Localization of storage facility
    c. Future repository for LILW after 2030
2. Decommissioning of the nuclear facilities: process and end point.

These two concept evaluations, made by a consultant group are to be finished later in 2014.

H. Safety of Radioactive Waste Management

Article 11. General safety requirements

Specific criteria are established by NRPA in connection with the operating licence review, annual status reports, and the license for radioactive waste management and discharges. The requirements are included in the safety analysis reports for both the radioactive waste management plant and the Himdalen facility. IAEA safety standards are used as guidance in issuing and reviewing the safety analysis reports.

A specific requirement and overarching premise for both currently operating and new facilities is that, for future generations, the burden emanating from present-day nuclear activities shall not be greater than those permitted for the current generation.

Protective measures providing for the effective protection of individuals, society and the environment constitute an integral part of the national framework legislation with due regard to internationally endorsed criteria and standards.

Article12. Existing facilities and past practices

The Norwegian facilities for radioactive waste management were built 30 to 50 years ago (except the Himdalen facility, which started operation in 1999), and have been continuously modernised with a view to safety enhancement. The Norwegian authorities have carried out regular inspections and reviewed and enforced safety procedures in connection with licence applications. These practices were also in effect at the time when the Joint Convention entered into force.

Radioactive waste management in Norway is primarily carried out by IFE at its Kjeller site. The Combined Disposal and Storage Facility is located at Himdalen, 26 km from the Kjeller site.

H.1 The Radioactive Waste Facility

The Radioactive Waste Facility was built in 1959. Before that, the radioactive waste was packed and in bags and temporarily stored in a storage building. This is a facility for receiving, sorting, handling, treatment and conditioning of radioactive waste. It receives all low- and intermediate-level waste (LILW) generated by Norwegian industry, hospitals, universities, research organisations and military forces. However, low-level waste containing only naturally radioactive nuclides (TE-NORM) is not received at IFE.

Remaining solutions of uranium containing plutonium and fission products from the decommissioned reprocessing test facility have now been solidified. The solidified uranium (yellow cake) is placed in 110 L drums which again are placed into 210 L drums and the spaces in between are filled with concrete. These drums are stored at the storage facilities at IFE until a disposal facility (or a new long-term storage facility) is available.

H.2 Storage Building 1

Storage building 1 was built in 1965–66 and has been in continuous operation. This building is 434 m^2 in size and is used for the storage of conditioned waste packages. When the Himdalen facility started operation in 1999, storage building 1 was filled with waste packages; these have now been disposed of at the Himdalen facility.

H.3 Storage Building 2

Storage building 2, built in 1977–78, has an area of 430 m^2 devoted to the storage of conditioned waste packages. This area is at present utilised for related purposes such as dismantling of smoke detectors.

H.4 Combined Disposal and Storage Facility at Himdalen

The facility is built into a hillside in crystalline bedrock. It has four caverns (halls) for waste packages and one slightly inclined 150-metre long access tunnel for vehicles and personnel. All the caverns and the access tunnel have a monitored water drainage system. A service and control room with service functions for personnel and a visitor's room are located along the tunnel. The rock caverns are excavated in such a way that about 50 metres of rock covering remains. This natural geological covering is for protection against intruders, plane crashes and other untoward events, although it is not intended to act as a main barrier in long-term safety calculations. Long-term safety will rely on the engineered barriers.

In each cavern, two solid sarcophagi have been constructed with a concrete floor and walls. When a section of the sarcophagus has been filled, it is planned that a roof will be constructed. The roof of the sarcophagus will be shaped to shed infiltrating ground water, and a waterproof membrane will be affixed to the concrete roof. Three caverns will be used for waste disposal, with drums and containers stacked in four layers. When one layer in a sarcophagus section has been filled with waste packages, it will be encased in concrete.

One of the caverns is used for storage for certain waste packages (166 of the old, retrieved waste packages containing some plutonium). The decision whether to retrieve the waste in the storage cavern or dispose of it by encasing it in concrete will be made on the basis of experience during the operational period and the safety reports to be prepared for closure of the facility, expected about the year 2030. There are no plans to retrieve any of the waste placed into the storage facility during operation.

Total capacity of the facility is 2000 m3 (approximately 10,000 210-litre drums).

For the long-term safety of the facility, the NRPA stipulates two basic requirements that must be fulfilled:

- Future generations have the right to the same level of radiation protection as the present generation.
- Except for a certain period of institutional control of 300 years, the safety of the facility should not rely on future surveillance and maintenance.

Safety criteria set by the Norwegian authorities are as follows:

- For the most likely scenarios, based on realistic calculations, doses to the most exposed individuals should not exceed 1 µSv per year.
- For other scenarios, a dose of 100 µSv per year to the potentially most exposed individuals should not be exceeded. These scenarios include: establishment of a well right outside the repository, while the repository has been filled with water; drilling through

the repository; all the waste deposited in the Glomma river in a 1 year period; the caverns are flooded shortly after closure.

The dose criteria are lower than those used and recommended internationally. This is achieved due to the relatively small amount and low level of activity of the inventory of the repository, and by applying the ALARA principle.

H.5 Retrieval of a near-surface LILW repository

As a result of the discussions preceding the construction of the Combined Disposal and Storage facility at Himdalen, the Storting (the Norwegian Parliament) decided that a shallow ground repository on the IFE premises at Kjeller should be retrieved and its contents transferred to Himdalen. The repository contained 997 drums and 19 other items of low- and intermediate-level radioactive waste that had been buried in clay in 1970. Retrieval of the drums started in August 2001 and was completed after 11 weeks of work. NRPA as well as the local community and media were kept informed throughout the process.

The waste drums proved to be in remarkably good condition, and the handling of them caused no significant problems. The original drums were cemented into slightly larger drums prior to preliminary storage at IFE and subsequent transport to Himdalen. Radiological monitoring of the remaining clay in the hole showed contamination far below the relevant clearance levels granted by NRPA. The total dose received by the involved personnel was less than 2.1 millimansievert. The maximum dose to any individual during the retrieval operation was less than 1.8 mSv. The total cost of retrieval, repacking, internal transport and radiological and environmental control was 3.6 million NOK.

Of the 997 drums, 166 were “plutonium drums”, containing a total of 35 grams of plutonium-239/240 originating from the former Uranium Reprocessing Pilot Plant’s treatment of spent fuel from the first JEEP reactor. In accordance with the same parliamentary decision, these drums have been placed in the storage hall of the Himdalen facility.

H.6 Environmental clean-up

In the early spring of 2000, IFE at Kjeller removed from the bed of the nearby Nitelva River approx. 180 m^3 of sediment contaminated by plutonium from liquid waste discharges in the years 1967–70. The liquid waste had been generated in conjunction with the operation of the Uranium Reprocessing Pilot Plant, which was shut down in 1968. NRPA required that sediments with a concentration of plutonium and americium isotopes (^{239}Pu, ^{240}Pu and ^{241}Am) exceeding 10 Bq/g were to be removed from the riverbed. This part of the riverbed had been accessible to the public in recent years due to low river-water levels for a few weeks every spring. Thus NRPA considered the contaminated sediment a potential risk to the public, even though the hot spots were now more than 50 cm below the sediment surface. The most contaminated volume of sediment (16 m^3), with a mean concentration of about 50 Bq/g and hot spots of the order of 100-1000 Bq/g, has now been disposed of at Himdalen. The remainder, with a mean concentration of about 2 Bq/g, was mixed with non-contaminated soil and clay and then used as filling compound in the hole left after retrieval of the 997 drums from the near-surface repository in 2001. The costs of the clean-up operation were approximately 4 million NOK.

Later that year, IFE decided to retrieve a 900-metre long section of a liquid waste discharge pipeline buried in the bed of the Nitelva River. It was no longer in use, having been replaced in 2000 by a new and shorter pipeline leading to a new discharge point about 800 m upstream of the old one. The clean-up operation was performed in March 2001. The retrieved pipeline was cut into two-metre long pieces and brought to the Radioactive Waste Treatment Plant at IFE. Plutonium-contaminated sediment was detected at one location. The concentration spot exceeded the NRPA’s clearance levels granted for Nitelva River sediment. About 40 m^3 of sediment were therefore removed and transported to IFE for treatment and subsequent disposal at the Himdalen facility. The costs of this second clean-up operation were about 0.8 million NOK. Considerable effort was expended to provide information to the media and the local community throughout the process.

Article 13. Siting of proposed facilities

Article 14. Design and construction of facilities

Before any new facilities for nuclear activities can be built in Norway, all obligations in these articles must be met, and decommissioning plans prepared. Among these obligations is the requirement to consult the relevant Convention Contracting Parties. For the siting, design and construction of a major facility for radioactive waste management, the same procedures as described under articles 6, 7 and 8 are to be followed. A repository for TE-NORM has been constructed in Gulen at the West coast of Norway and taken into service in 2008. At present, Norway has no further plans for constructing new waste management facilities, but some initial plans exist for a (long term) storage facility for spent fuel. This facility is expected to have storage capacities for long lived waste as well.

Article 15. Assessment of safety of facilities

The Combined Disposal and Storage Facility for LILW at Himdalen was put in operation in 1999, the licence for construction was given to the Directorate of Public Construction and Property (Statsbygg) by a Royal Decree in 1997.

IFE was given a renewed licence for operating the facility until 30 April 2012 by a Royal Decree 25 April 2008. This licence has further been renewed for the operation of the facility till 28 April 2028, with the condition that the facility's SAR will be reviewed periodically every five years.

Article 16. Operation of facilities

Some waste management facilities were constructed before the Act on Nuclear Energy Activities entered into force in 1972, so this act could not regulate the original design and initial construction of the facilities. Nevertheless, the design and construction of the Norwegian facilities have been consistent with international practice. Later modifications have been subject to approval by NRPA and regulated through operational limits and conditions in accordance with the Act and requirements stipulated in the licences.

Any incidents at the waste management facilities or at the Himdalen facility are to be reported directly to NRPA, without undue delay.

Article 17. Institutional measures after closure

The Himdalen disposal facility is owned by the state (Statsbygg as of today), so the responsibility for post-closure measures will rest with the state. As yet, no decision has been taken concerning the form in which information and records will be kept.

An institutional control period of 300 years or more will be effected for the Himdalen disposal facility (exact length to be determined at the time of closure). Monitoring of the area will be implemented, and there will also be restrictions on land-use.

I. Transboundary Movement

Article 27. Transboundary movement.

All nuclear activities, including transboundary movements, are regulated by the Act of 12 May 1972 No. 28 on Nuclear Energy Activities with regulations, and the Act of 12 May 2000

No. 36 on Radiation Protection and Use of Radiation with regulations.

Norway does not export spent nuclear fuel or radioactive waste. However, irradiated nuclear fuel as test specimens as part of the bilateral research programme at IFE are imported from participants in the OECD Halden Reactor Project for further irradiation at the Halden Boiling Water Reactor. After irradiation, these specimens are usually exported back to the owner for further investigation and study. A few of these specimens are studied at the laboratories at Kjeller. This generates some small amounts of waste, which are disposed of together with the low- and intermediate level waste. Some of the waste, generated in connection with the examinations, is repacked and returned to the owner of the spent fuel. The spent fuel that is imported and exported to and from Norway is owned by the 17 countries that are present participating in the OECD Halden Project.

All transfers to and from foreign countries must be authorised by the regulatory body, also to ensure compliance with the provisions of the Convention on the Physical Protection of Nuclear Materials and other relevant conventions.

Export and import of radioactive waste require authorisation. Transit transportation in Norway of nuclear material in general is not permitted without a licence. To date, such transits have never been performed.

J. Disused Sealed Sources

Article 28 Disused sealed sources

Regulations on Radiation Protection and Use of Radiation (29.10.2010) specify NRPA as the regulatory body for all aspects of handling radioactive sources. This regulation distinguishes between very low, medium and high activity sealed sources. Authorization is needed before using a high-activity sealed source: 2,000,000 times of the exemption values given as part of the regulation, roughly similar to levels set out in IAEA Safety Series No. 115. Notification must be sent to the authority (NRPA) in case of use of a medium-high activity source, these are typically industrial gauges. For very low activity sources, no authorization or notification is needed; such sources are generally below the regulation exemption levels.

NRPA maintains electronic records of sealed sources above exemption levels, like sources used in blood irradiators, industrial radiography, oil and gas well logging, medical therapy, and industrial gauges. The information on sealed sources is being stored in a web-based register which enable the owners and users of radiation sources to make applications and notifications to NRPA directly on the web. Owners and users are also able to check and verify the information associated with their enterprise.

Starting with the entry in to force of the revised Radiation Protection Regulations 1 January 2011 all import and export of IAEA category 1 and 2 sources requires an authorization from the NRPA.

Distributors of medium and high activity sources are required to have authorisation from NRPA. When NRPA issues authorisations for companies to buy, sell or use sealed sources, it is with the requirement that disused sources are to be returned to the manufacturer. This is strictly enforced,. However, if no viable options for a license holder in Norway are available, NRPA may decide that that the source is to be sent to IFE for treatment and for storage or disposal at the Himdalen repository.

It is the responsibility of the licence holder to ensure that disused sealed sources are handled in a safe manner and that they are ultimately returned to the manufacturer or sent to IFE. If the license holder is in financial difficulty or out of business, safety and proper disposal of the disused sealed sources will be handled by a case-by-case basis. NRPA may take the responsibility for the source(s). License holders are generally not required to provide financial assurance for the decommissioning of their facility and disposal of disused sources when applying for a license. So far this has not caused any major problems in Norway.

Practical implementation of the return requirement means that the sources are re-exported to a manufacturer abroad or sent to IFE Kjeller for treatment and for storage or disposal at the Himdalen repository, if the source complies with the requirements set out in the license for Himdalen. The waste treatment plant at IFE Kjeller can treat, store and dispose of disused sealed sources in a safe manner. (Disused sealed sources are treated at the same place as other wastes.) The same regulatory requirements as for other radioactive wastes are in force for long-term storage facilities for disused sealed sources. The same safety precautions, including monitoring activities, are required during handling of disused sealed sources.

The owner pays for the treatment and storage at IFE Kjeller. The cost for disposal at Himdalen is covered by government funding. The Ministry of Trade and Industry has a separate agreement with IFE for the operation of the Himdalen facility and general waste handling.

There is only one producer of radioactive sources in Norway: this is IFE, which produces sources at the Jeep II reactor. IFE's licence for this production is part of the general licence to own and operate nuclear installations and a permit for the production is given by the NRPA with statutory basis in the Radiation protection Act with regulations. The general licence contains comprehensive requirements for radiation protection, safety and security. As a distributor of radioactive sources, IFE is also required to provide annual reports to NRPA specifying sources, activities, names of buyers etc.

Norwegian authorities allow re-entry of disused sealed sources on a case-by-case basis. Norwegian-produced instruments with sealed sources, which may be produced in a third country, are permitted re-entry.

Orphan sources have been identified in Norway. NRPA has noted that many licensees do not inform the regulatory authorities when operations are closed down and installations are being decommissioned. Thus, NRPA has noted several instances where sources have been removed or sent to other companies without proper notification, as stipulated by the regulations in force. If an orphan source is found, the normal procedure is that NRPA attempts to find the owner, and, if relevant, also report the case to the police. If the owner is not found, NRPA makes sure the source is being handled properly as radioactive waste. If the source is found to be orphaned, deliberately or by an act of negligence, the police will consider prosecution and further reactions. Fines up to NOK 2 million (€ 250 000) have been given.

At the Storskog border point (Norway–Russia) a monitoring portal has been in operation for almost eleven years. The customs have portable measuring equipment across the country. Several other governmental organisations have similar handheld equipment, for example Coast Guard and Civil Defence organisations. NRPA assists them (second-line services) in case of alarms. Most private companies dealing with scrap metal or other businesses that might have contaminated waste have equipment/control monitors to detect such sources before they have been sent to a foundry or are being melted down. Several orphan sources have been detected this way.

K. General Efforts to improve Safety

The main issues that have been identified and discussed in this report are:

- The stabilization of the spent metallic fuel cladded with aluminium. IFE is assessing the need for monitoring and treatment of this fuel.

A consultant group formed by the Government is working on:

- Establishing a new storage facility for spent fuel and LLW.
- Process and end-point of the decommissioning of the nuclear facilities in Norway.

In 2014 NRPA, together with external experts, conducted system audit of the research reactors of the IFE. In this audit, management and organizational issues related to the safety were reviewed. It was found out that there is a need for improvement in safety culture, management and quality control. The findings from the system audit have been followed up by NRPA, but require a long-term perspective.

The license for the HBWR in Halden expires in December 2014. An application for a new license has been reviewed by NRPA, but the final license will be issued by the Government. The license for the JEEP II reactor expires in December 2018.

L. Annex

References to national laws, regulations, requirements, guides etc.

Act of 12 May 1972 No. 28 on Nuclear Energy Activities

- Regulations of 2 November 1984 on the Physical Protection of Nuclear Material.
- Regulations of 15 November 1985 on Exemption from the Act on Atomic Energy Activity for Small Amounts of Nuclear Material.
- Regulations of 12 May 2000 on Possession, Transfer and Transportation of Nuclear Material and Dual-use Equipment.
- Regulations of 14 December 2001 on Economical Compensation after Nuclear Accidents

Act of 12 May 2000 No. 36 on Radiation Protection and Use of Radiation

- Regulations on Radiation Protection and Use of Radiation of 29 October 2010.
- Regulations on the Applicability of the Act on Radiation Protection and Use of Radiation on Svalbard and Jan Mayen of 9 May 2003.

Act of 13 March 1981 Concerning Protection against Pollution and Concerning Waste

- Regulation of 1 November 2010 on the application of the Pollution Control Act on Radioactive Pollution and Radioactive Waste
- Regulation of 1 June 2004 on the Recycling of Waste
- Regulation of 1 June 2004 on Pollution control

Norwegian Radiation Protection Authority (STATENS STRÅLEVERN), Implementation of the Obligations of the Convention on Nuclear Safety in Norway (Report 2013:x).

Norwegian Radiation Protection Authority (STATENS STÅLEVERN), Norwegian work on establishing a combined storage and disposal facility for low and intermediate level waste (Report 1995:10), IAEA-WATRP review team, (1995).

NOU 2001:30 (Official Norwegian Report), Evaluation of strategies for final disposal of high level reactor fuel (in Norwegian).

Technical Committee on Storage and Disposal of Metallic Uranium Fuel and Al-clad Fuels, Reccomendations for the Conditioning of Spent Metallic Uranium Fuel and Aluminium Clad fuel for Interim Storage and Disposal (in English) http://www.regjeringen.no/upload/NHD/Vedlegg/rapporter_2010/tekniskutvalgsrapport2010.pdf

NOU 2011:2 (Official Norwegian Report) Interim storage solution for spent nuclear fuel and long-lived intermediate level waste (in Norwegian) http://www.regjeringen.no/pages/15663778/PDFS/NOU201120110002000DDDPDFS.pdf

Statens strålevern
Norwegian Radiation Protection Authority

StrålevernRapport 2014:1
Virksomhetsplan 2014

StrålevernRapport 2014:2
Strålebruk i Norge

StrålevernRapport 2014:3
Nordisk-baltisk atomberedskapsøvelse: NB 8 Nuclear Emergency Exercise 2013

StrålevernRapport 2014:4
Overvaking av radioaktivitet i omgivnadene 2013

StrålevernRapport 2014:5
Strålevern i utdanningene for helsepersonell

StrålevernRapport 2014:6
Representative doser i Norge – 2006–2009

StrålevernRapport 2014:7
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

ISSN 0804-4910 (print)
ISSN 1891-5191 (online)