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

National Report from Norway to the sixth review meeting, 21 May – 1 June 2018

List of Abbreviations

| | |
|---|---|
| FIN | Ministry of Finance |
| 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 |
| KS1 | Quality Assurance report |
| KVU | Concept evaluation study |
| 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 |
| MTO | Man, Technology and Organisation |
| NFD | Ministry of Industries and Fisheries. |
| NORA | Norwegian 0 (zero) - power Reactor Assembly |
| NOU | Official Norwegian Report |
| NRPA | Norwegian Radiation Protection Authority |
| OECD | Organisation for Economic Co-operation and Development |
| NORM | Naturally Occurring Radioactive Material |
| WATRP | Waste Management Assessment and Technical Review Programme |

# Contents

# A. Introduction

This is the Norwegian report to the sixth 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, 21 May – 1. June 2018. 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 Radiation Protection Authority (NRPA). 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 sixth report is a revision of the fifth 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.

The NRPA was partly integrated within the Directorate of Health in January 2016. However, this decision was reversed as of July 1, 2017 and now NRPA is again an independent regulatory body under the administrative authority of the Ministry of Health and Care Services. The NRPA is also a directorate under the Ministry of Climate and Environment in relation to pollution control and radioactive waste management.

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 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. 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.

IFE has more than 60 years of experience in handling and storing spent fuel. To date, there have been no major incidents at Norwegian facilities with respect to these activities. The amount of spent fuel generated from the nuclear reactors annually is approximately 145 kg, which is stored in IFE's facilities close to the reactors. After 60 years of reactor operation, more than 16 tonnes of spent fuel is stored in several storage areas at Kjeller and in Halden.

At the JEEP II, the standard fuel is 3.5 % enriched uranium dioxide with anodized aluminium cladding. The spent fuel is first wet stored in the fuel pit inside the reactor building, which later transferred to the dry spent fuel storage building in Kjeller site.

At the HBWR, the standard fuel is ca. 6 % enriched uranium dioxide with Zircaloy-4 cladding. HBWR also utilizes higher enriched fuel for the experimental purposes. The spent fuel is first wet stored in a pool in the reactor hall, before it is moved to the storage building outside the reactor hall for further storing in pool and dry storage. Water in all the above pools is continuously monitored.

Spent fuel and long-lived waste (LLW) will be stored until final disposal is possible.

The KLDRA facility in Himdalen, taken into service in 1999, consists of four rock caverns with two concrete sarcophaguses in each cavern. The facility contains a storage part and a disposal part. The current policy is to dispose of all the Low and Intermediate Level Waste (LILW) in Norway (except NORM, high activity disused sealed sources and long-lived intermediate level waste) at the KLDRA facility in Himdalen. Estimates show that this facility has sufficient capacity to accommodate disposal needs until 2030.

In 2015 the government appointed a committee that produced concept evaluation studies (KVUs). The committee prepared and submitted two reports on i) the handling of Norwegian spent fuel and other radioactive waste, and ii) the future decommissioning of nuclear facilities in Norway. The KVUs made estimations of the future decommissioning waste, spent nuclear fuel and other radioactive waste. Further details can be found in section G.

Waste with NORM is regulated as radioactive waste in Norway. There are four repositories in Norway for radioactive waste with NORM.  Two repositories have the license for acid forming rocks with

NORM, named Borge waste repository and Heggvin Alun. The main repository for hazardous waste, NOAH Langøya, is also licensed for radioactive waste.

A repository for NORM from the petroleum industry has been constructed in Gulen at the West coast of Norway and taken into service in 2008.

## B.1 Classification of radioactive waste in Norway

In the Norwegian regulations, classification of radioactive waste has been established, based on the Pollution Control Act, in the Regulations on radioactive pollution and waste chapter 16. Annexes I a and I b provide limit values for what is considered as radioactive waste and what is considered as radioactive waste intended for disposal in a radioactive waste repository, respectively. The limiting values for what is considered to be radioactive waste are specified as specific activity (Bq/g) and for radioactive waste disposal as specific activity (Bq/g) and total activity (Bq) for each radionuclide.

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 Basic Safety Standards.

In comparison with the IAEAs classification of radioactive waste (GSG-1), exempt waste (EW) is considered to be non-radioactive waste in the Norwegian regulations.

Very short lived waste (VSLW) is not explicitly described in the Norwegian regulations. However, the classification of this waste fraction should be seen in connection with the use of BAT (best available technique/technology) and requirements in the regulatory framework to reduce waste.

Very low level waste (VLLW) is defined according to the Norwegian classification. It is radioactive waste with activity levels in the range between what is considered as being radioactive waste and radioactive waste intended for disposal in a radioactive waste repository.

The IAEA classification for low level waste (LLW), intermediate level waste (ILW) and high level waste (HLW) will all fall under the classification of radioactive waste intended for disposal in a radioactive waste repository in the Norwegian regulations.

The LILW has been conditioned and stored at Kjeller since the start of the radioactive waste management facility. The LILW from the HBWR is routinely transported to the Kjeller site for treatment. However, with an emerging shortage of storage capacity at the Kjeller site, 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 (KLDRA) in Himdalen. In KLDRA storage, drums containing small amounts of plutonium are stored. The final decision on the disposal of these drums has been deferred in order to ease public acceptance of the siting of the facility.

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.

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. 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 policy of spent fuel; however, it may be considered in the future;

(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 defense programs 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 two sites with management facilities for spent nuclear fuel in Norway, as seen at the map in Figure D-1, operated by IFE[1].

The fuel used in the HBWR at Halden is low enriched uranium dioxide, mostly 6 %. However, for the experimental purposes the enrichment of $UO_2$ can be achieved up to, but no more than 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. The fuel unloaded from the HBWR reactor is first cooled in the spent fuel storage pool in the reactor hall, then transferred to another storage pool in the bunker building. Later the spent fuel will be stored in the dry storage in the bunker building.

The spent metallic natural uranium fuel from the previous core loadings of the HBWR is stored in the dry storage compartment in the bunker building.

The fuel used in JEEP II at Kjeller is 3.5 % enriched uranium dioxide. The fuel unloaded from the reactor is first cooled in the water pond in the reactor hall, and later transferred to the dry fuel storage at Kjeller. The dry storage facility at Kjeller consists of a concrete block with several storage steel pipes 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 also stored at Kjeller in a separate storage facility at the site. The storage pipes 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 research 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 20 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.

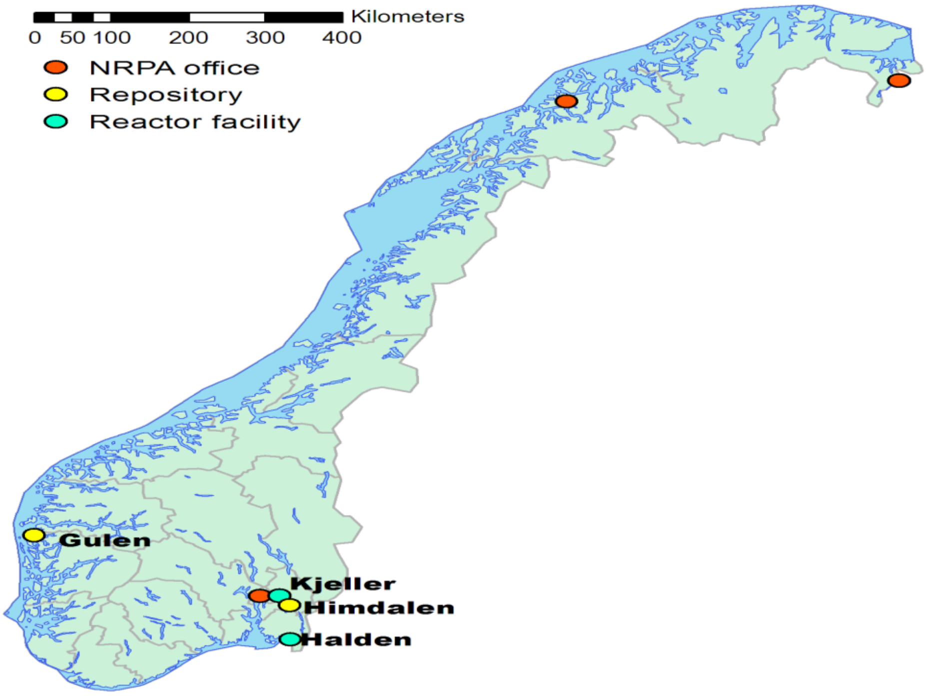



*Figure D-1: Map of Norway with relevant sites*

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

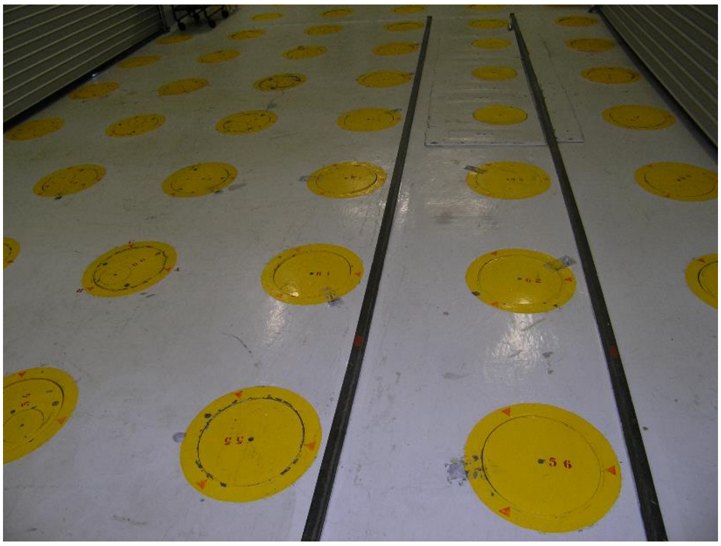


*Figure D-3: Spent fuel storage facility. Kjeller site*

## D.2 Spent Fuel Inventory

In total Norway has around 17 tonnes of spent nuclear fuel, of which six tonnes are stored at Kjeller and 10 tonnes in Halden. Approximately 12 tonnes of the fuel has aluminium cladding, of which 10 tonnes is metallic uranium fuel and remainder is uranium dioxide. The fissile content of the spent fuel is given in the Table D-1. IFE is reviewing and making a complete source term inventory of the all the irradiated fuel in Norway.

| Type of material | IFE-Kjeller (kg) | IFE-Halden (kg) | Grand Total (kg) |
|---|---|---|---|
| Enriched uranium | 2 200 | 4 175 | 6 375 |
| Natural uranium<br>*(Incl. Metallic uranium)* | 4 377<br>*(3 125)* | 7 021<br>*(6 918)* | 11 398<br>*(10 043)* |
| Depleted uranium | 12.7 | 13.5 | 26 |
| Thorium | 100 | 12.6 | 112.6 |
| Plutonium | 7.5 | 15.8 | 23.3 |

*Table D-1: Inventory of irradiated nuclear material in Norway as of May 2017. Inventory of reactor cores are included.*

## 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 Kjeller site 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 before storage or deposition and is the only facility of this type in Norway. It receives all LILW generated by Norwegian industry, hospitals, universities, research organisations and defence.

*Storage Building 1 (built 1965–66)*

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

*Storage Building 2 (built 1977–78)*

The building area is 430 $m^2$ and is used partly for storage of conditioned waste ready for transport to the Himdalen facility, and partly for storage for un-irradiated material.

*Figure D-4: Radioactive waste facility, Kjeller site*

*KLDRA Himdalen (built 1997–98)*

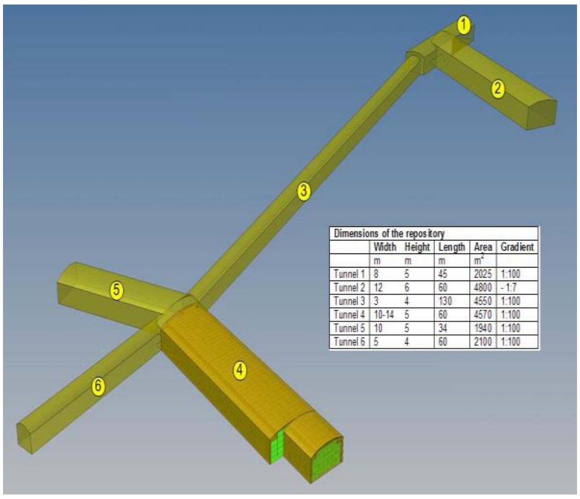
The builder and owner of the KLDRA facility in Himdalen is Statsbygg (Directorate of Public Construction and Property), which is organised under the Ministry of Modernisation. All organisations receive their funding from the respective ministries on a yearly basis following the Norwegian State Budget.

KLDRA 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.

The operator of the KLDRA facility is IFE. The Norwegian Government has however proposed in the national budget for 2018 to follow international best practice and to establish a separate organisation for the handling of nuclear waste and the future decommissioning of nuclear installations.

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

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




| Dimensions of the repository | | | | | |
|---|---|---|---|---|---|
| | Width | Height | Length | Area | Gradient |
| | m | m | m | $m^2$ | |
| Tunnel 1 | 8 | 5 | 45 | 2025 | 1:100 |
| Tunnel 2 | 12 | 6 | 60 | 4800 | - 1:7 |
| Tunnel 3 | 3 | 4 | 130 | 4550 | 1:100 |
| Tunnel 4 | 10-14 | 5 | 60 | 4570 | 1:100 |
| Tunnel 5 | 10 | 5 | 34 | 1940 | 1:100 |
| Tunnel 6 | 5 | 4 | 60 | 2100 | 1:100 |

*Figure D-5: NORM facility at Gulen*

The repository is operated by Wergeland Halsvik AS and is situated in an underground rock formation. It consists of an entry tunnel, a tunnel for NORM 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 between the barrels with a cement matrix. The repository tunnels are to be filled with waste-drums, cemented in concrete mould castings.

There are four physical barriers to stop the spread of radioactivity from the disposed waste. The first barrier consists of the plastic drum in which the waste is disposed. 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 has requested that in addition to the company's own fund for the closure and post closure remediation, there must be a guarantee from the Ministry of Petroleum and Energy as a fund in case the operator is not able to operate the repository.

### *Inventory and capacity of NORM waste*

The inventory of the repository as of January 2017 is 1415 tons of waste, with a total activity of 38.95 GBq.

The operator has to keep journals over the total activity and activity for $^{226}Ra$, $^{228}Ra$ and $^{210}Pb$. It has been estimated with the present yearly generation of NORM waste from the petroleum industry that the Gulen facility can be operated for the next 90 years.

## D.4 Inventory of the Radioactive Waste

In Table D-2 the inventory of Norwegian LILW radioactive waste is shown. 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 waste generators.

In addition 21 drums (1210 kg uranium) of yellow cake from the pilot reprocessing plant and 8 drums (41 GBq) containing radium needles previously used in hospitals are stored at the Kjeller site.

## D.5 Decommissioning

No nuclear facilities are in the process of being decommissioned in Norway.

| Radionuclide | Himdalen Repository Capacity (Bq) | Himdalen Current Storage (Bq) |
|---|---|---|
| H-3 | 1,01E+14 | |
| C-14 | 5,43E+10 | |
| Cl-36 | 4,63E+07 | |
| K-40 | 3,50E+04 | |
| Co-60 | 1,35E+13 | 6,6E+08 |
| Ni-63 | 1,70E+13 | |
| Kr-85 | 2,75E+11 | |
| Sr-90 | 2,19E+12 | 1,3E+11 |
| Tc-99 | 8,92E+08 | |
| I-129 | 3,91E+07 | |
| Ba-133 | 5,68E+10 | |
| Cs-137 | 5,03E+13 | 1,4E+11 |
| Eu-152 | 1,95E+09 | |
| Eu-154 | 2,10E+09 | |
| Hg-203 | 1,64E+07 | |
| Pb-210 | 5,08E+06 | |
| Ra-226 | 6,76E+09 | |
| Ra-228 | 2,41E+08 | |
| Ac-227 | 2,47E+09 | |
| Th-232 | 9,71E+08 | |
| Pu-238 | 6,20E+11 | 5,0E+11 |
| Pu-239 | 2,50E+10 | 3,1E+10 |
| Pu-240 | 8,81E+10 | 1,2E+11 |
| Pu-241 | 9,43E+12 | 1,6E+13 |
| Pu-242 | 2,43E+08 | 3,3E+08 |
| Am-241 | 6,43E+12 | |
| Cm-244 | 4,08E+09 | |
| U-233 | 1,27E+02 | |
| U-234 | 2,30E+07 | |
| U-235 | 4,77E+06 | |
| U-236 | 3,90E+06 | |
| U-238 | 1,02E+09 | 1,7E+08 |
| Total No. of 220-litre drums | 6038 | 166 |

*Table D-2 Inventory of Norwegian radioactive waste at KLDRA Himdalen as of December 2016*

# 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/her with the approval of the "*Storting"* (the Norwegian Parliament). Laws 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, such as the NRPA.

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 also a directorate 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 under the Action Plan for Nuclear Safety in North West Russia and Ukraine, and under the Ministry of Defence concerning the traffic of nuclear submarines along the Norwegian coast. NRPA also provides assistance and advice to other ministries on matters related to radiation protection, radioactive waste management, nuclear safety and security.

The Norwegian Radiation Protection Authority:

- is the autonomous decision making authority responsible for the area of nuclear safety, security and non-proliferation following the Nuclear Energy Act directly subject to the Ministry of Health and Care Services
- is the authority for the Act and Regulations on Radiation Protection and use of Radiation.
- has responsibilities and an autonomous decision-making authority following the Pollution Control Act directly subject to the Ministry of Climate and Environment

Spent fuel management and radioactive waste management, including transboundary movements, are regulated by three legal instruments, the Atomic Energy Act 12 May 1972, the Pollution Control Act 13 March 1981 with Regulation on waste and the Radiation Protection Act 12 May 2000.

The Ministry of Health and Care Services did consider a full integration of NRPA within the Directorate of Health, in 2016. However, the decision was reversed in July 2017, due to assessment made by the Norwegian Ministry of Foreign Affairs (MFA) to fulfil the obligations and recommendations of the International Conventions signed and ratified by the government of Norway.

## 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 licence expires 31 December 2018 except for the licence for HBWR, which expired 31 December 2014. HBWR got its licence renewed by Royal Decree of 5 November 2013 with an expiry of 31 December 2020. The main basis for the licence is the submitted and approved Safety Analysis Reports (SAR) for the two reactors; the connected auxiliary facilities; and the KLDRA in Himdalen.

## E.2 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.

## E.3 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 and the Pollution Control Act..

## E.4 Other Acts, Regulations, and Decrees

The Royal Decree of 23 August 2013 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.

NRPA has a total staff of about 125 persons and a total annual budget of approximately 110 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 waste and issues approval certificates for transport packages.

Applications for licences and renewals of licences for the operation of nuclear facilities are submitted to the Ministry of Health and Care Services. On behalf of the ministry, NRPA assess the applications. The assessment with recommendations is then sent to the ministry for further hearing and decision. Licence is finally given by the Government. NRPA also carries out regular inspections and audits to ensure that the requirements of a licence are fulfilled.

NRPA will carry out regular inspections and audits to ensure that regulatory and licence requirements are fulfilled and complied with. NRPA is also responsible for issuing permits for radioactive waste management and discharges under the Pollution Control Act 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.

NRPA may at any time independently arrange for public hearings and by other means 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 KLDRA facility in Himdalen. It is the responsibility of IFE to ensure the highest possible levels of the safety and security 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 can apply for a new licence. The licensee is also responsible for providing the necessary financial and human resources for maintaining safety and radiation protection at an appropriate level.

The current licence for the IFE's nuclear facilities expires:

- JEEP-II reactor Kjeller 31 December 2018, IFE has applied for the renewal of the operational license till 31 December 2028
- HBWR reactor Halden – 31 December 2020.
- KLDRA – Combined Disposal and Storage Facility – 28 April 2028.

NRPA also issues separate permits 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 to avoid harmful effects on health and environment.

### *Article 22. Human and financial resources*

Human and financial resources of NRPA are not explicitly covered by legislation. However, the Norwegian regulatory body was established in 1993, 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 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 are also contracted.

IFE has a total staff of ca 600 persons, of which ca 100 persons are employed for reactor operations and radioactive waste treatment facility. 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 own personnel and pays an annual inspection fee to the NRPA.

The Act on Nuclear Energy Activities and the Pollution Control Act authorises NRPA to impose sanctions on IFE in the event that safety standards are not maintained at an acceptable level. All NRPA requirements can be appealed to the Ministry of Health and Care Services, or the Ministry of Climate and Environment in case of releases to the environment and waste management; 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 until the requirements has been fulfilled. In case of criminal activities, NRPA is to report to the police. A proposal has however been presented to the Parliament this spring to empower the NRPA with the right to impose administrative fines on the operator.

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

### *Article 23. Quality assurance (QA)*

Based on the Regulation relating to Systematic Health, Environmental and Safety Activities in Enterprises and the licence, 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.

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 GSR Part 1.

NRPA has developed a quality assurance system with written procedures for licensing and inspection activities. This system is under ongoing 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, as a result of nuclear activities.

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 facilities as well as lower doses sustained by staff.

The operational limits and conditions for IFE's nuclear facilities and discharges are specified in permits according to the Pollution Control Act in order to ensure that discharges are limited and that measures are taken to reduce them 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 maintains 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 main element in the response organisation is the Crisis Committee, headed by the Director General at the Norwegian Radiation Protection Authority.

## F.1 Overview of Preparedness Elements

### *F.1.1 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 relevant ministries;
- the Ministerial Coordination Committee;
- the Crisis Committee for Nuclear Preparedness (CCNP);
- the Advisors to the Crisis Committee;
- the Secretariat for the Crisis Committee (NRPA);
- the County Governors.

### *F.1.2 The Ministries*

The ministries are responsible for emergency preparedness within their area of competence. In order to deal effectively with the early phase of a nuclear event, the ministries have transferred responsibility for remedial actions to the Crisis Committee.

### *F.1.3 The Crisis Committee*

The Crisis Committee for Emergency Preparedness consists of the representatives of the following institutions:

- the Norwegian Radiation Protection Authority;
- the Directorate for Civil Protection;
- the Norwegian Armed Forces;
- the  Directorate for Health;
- the Norwegian Costal Administration;
- the Norwegian Food Safety Authority;
- the National Police Directorate and
- the Royal Ministry of Foreign Affairs;

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

- order the acute evacuation of local communities in cases where the emission source, for example a local reactor, a wrecked vessel with a reactor, or satellite fragments, represents a direct threat to lives and health locally,
- order short-term measures or restrictions in the production of foodstuffs, for example by keeping domestic animals inside or postponing harvesting,
- order or advise the decontamination of affected people,
- advise the general public to keep indoors,
- advise the use of iodine tablets,
- provide nutritional advice, for example by advising people to refrain from consuming certain contaminated foodstuffs, and

- offer advice on other measures, including measures to prevent or reduce environmental contamination.

NRPA heads the Crisis Committee. The NRPA is also mandated to make the same decisions as the Crisis Committee until the Committee is assembled.If time permits, the Crisis Committee must consult with the ministries before deciding on actions.

### *F.1.4 Emergency Levels*

The Crisis Committee operates with three emergency levels: “0”, “1” and “2”. These apply to accidents domestic as well as internationally. Level “0” is operation as usual, level “1” is declared when a situation of significance occurs, which might develop in severity. Level “2” is declared when there is a risk of radiological consequences.

No countermeasures are automatically implemented on the basis of declared levels of emergency. Rather, they are implemented based on the type of incident faced as well as the assessment of the situation (see below)

### *F.1.5 The Advisors to the Crisis Committee*

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

During an event, the tasks of the Advisors assist the Crisis Committee with:

- procuring relevant information and data to establish the best possible basis for making assessments and decisions. This includes information about
- the accident site, incident, and emission source,
- the scope and composition of the emission, if relevant,
- meteorological conditions,
- radioactive substances in the air and as fallout on the ground,
- contamination of foodstuffs, potable water, and the environment, and
- other relevant information.

### *F.1.6 The Secretariat for the Crisis Committee*

NRPA is The Secretariat for the Crisis Committee and is responsible, *inter alia*, for alerting the Nuclear Emergency Organisation, and relevant international bodies. The Secretariat organises a 24/7 Officer on Duty Service.

### *F.1.7 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.

### *F.1.8 Standing Preparedness*

Norway operates a national automatic gamma monitoring network, consisting of 33 continuously run stations. The data acquired is directly available to the competent authority, the emergency response organisation, and the public via radnett.nrpa.no.

In addition, Norway has6 high volume air samplers, where 4 have alarm capabilities with GM-counters on top of the filters.

The Nordic countries have established an agreement that facilitates the access to all the data from the national automatic gamma monitoring networks directly available to each other. Similar agreements are in place with the rest of the Baltic Sea countries.

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.

### *F.1.9 Dimensioning Scenarios*

The Norwegian Government has adopted 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. serious accident abroad that can affect Norwegian interests, but not territory.

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.

### *F.1.10 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 – with a serious accident at a Finnish NPP with possible impact also in Norway). In addition, a large exercise was arranged in co-operation with the Ministry of Foreign Affairs (scenario was nuclear accident abroad with 3000 affected Norwegians in area). 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, including the ConvEx-3 conducted in June 2017 where the NRPA had the chance to train 36 hours in continuation, internal procedures i.e. measurements, consequence understanding, USIE, understanding and reporting on the situation internally in Norway as well as with other bilateral partners. The NRPA participated for the duration of the exercise. The lessons learned from the exercise are being implemented. 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, orphan sources, and NPP accidents There is no predefined regularity in these exercises.

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

## F.2 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 has taken 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.

## F.3 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.

*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, 2012, and 2016 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” and are continuously updated. 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 agreed in principle to partly finance the decommissioning of the nuclear facilities.

# G. Safety of Spent Fuel Management

Norway’s first research reactor JEEP I reached criticality in July 1951 at Kjeller, east of Oslo. The reactor was later decommissioned in 1967. The Halden Boiling Water Reactor (HBWR) became operational in 1959. The NORA reactor, was in operation in the period 1961 - 1968 and later decommissioned. JEEP II was built in 1965–66 and reached criticality in December 1966.

*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 operating reactors and the past 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*

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, which later was partly 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. The radioactive waste from the decommissioning of the pilot plant has been disposed of at the combined disposal and storage facility in Himdalen. Low-level liquid uranium solution from the pilot reprocessing plants have been solidified into yellowcake and are stored at the Kjeller site.

At Kjeller, the spent fuel from the JEEP II reactor is first cooled in a pool inside the reactor hall. 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 pipes. After this the fuel is placed in a dry storage facility consisting of a concrete block with several storage steel pipes covered by shielding plugs. The concrete block is placed under a building specially designated for loading and unloading transport of radioactive material.

Spent fuel from the former JEEP I (1951–1967) and NORA (1961–1968) reactors is stored in a separate spent fuel storage building at the Kjeller site (JEEP I pit storage). The storage pipes 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.

The capacity of the storage facilities for spent fuel will be reached around 2024 in Halden and around 2032 at Kjeller, given that the operation continues as present.

As a follow-up of the Fukushima Dai-chi accident, IFE conducted “stress tests” to all the IFE’s nuclear facilities, including spent fuel storages at Halden and at Kjeller. At Halden, the spent fuel from the HBWR is stored in fuel pits in the reactor hall. The water pipe inlets and outlets are at the top of the pits, and thus a water pipe break will not result in leakage of water. If a station blackout occurs with a full core loading in the fuel pit, the calculations have shown 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. For the safety measure, an auxiliary water pipe with redundant waster source has been installed in the HBWR spent fuel pit. The stress test analysis for Kjeller showed that no extra actions were required to enhance the robustness of the safety of the fuel pits at JEEP II reactor.

In 2012, IFE conducted numerous tests on a fuel element of the JEEP I reactor to investigate the status of the metallic uranium fuel. Traces of uranium hydride and corrosion were found in the JEEP I fuel as a result from these investigations.  This was an indication of the presence of moisture in the dry storage of the spent fuel.

NRPA instructed IFE to make a full investigation of all the stored spent fuel of JEEP I at Kjeller and the first charge of HBWR at Halden. JEEP I fuel was given priority over HBWR fuel because of the presence of the uranium hydride. There were several reasons for this. The first charge of the HBWR was metallic natural uranium with aluminium cladding which was anodized. This makes the HBWR fuel more chemical stable than the metallic fuel from JEEP I. In addition there were found presence of uranium hydride in JEEP I fuel, and the non-optimal conditions for the JEEP I fuel is not optimal. The investigation campaign was divided in four phases as follows:

1. Phase 1: Opening of storage positions, partial lifting of storage pipes and sampling of atmosphere inside the storage pipes to check the presence of hydrogen
2. Phase 2: Leakage test of storage pipes.
3. Phase 3: Complete lifting of storage pipes from underground positions.
4. Phase 4: Inspection of the condition of spent fuel

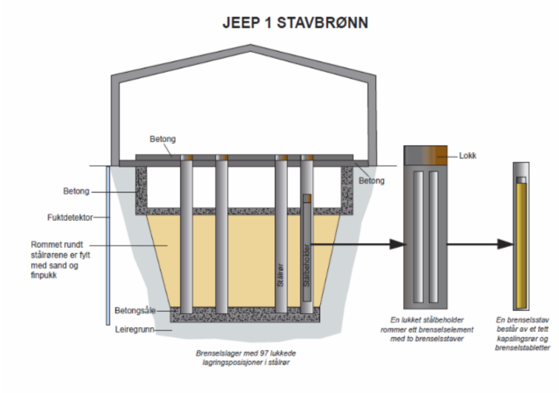



*Figure G-1: The construction of spent fuel storage building for the historical spent fuel from JEEP I and NORA reactor*

The inspections started in 2015 and IFE has completed the first two phases of the project and work on the phase-3 was started in 2017.

For the work that has been conducted at “JEEP I pit storage” till now, the following observations has been made and reported by the IFE:

- The environment inside the fuel storage positions is damped and rusted.
- The hydrogen gas in many storage pipes has been monitored by opening its endcaps and sampling.
- The storage pipes are intact such that they can still be considered as barrier against radioactive releases. However, the presence of gases indicated the onset of corrosion in many storage pipes.
- On scrapping and cleaning the spent fuel storage positions against corrosion, the visual inspection has shown the seeping of water inside several storage positions.
- The fuel assemblies, where water seepage has been detected, have been moved to other dry storage positions.

Due to the presence of water in several storage positions the work on phase 3 has been stopped. IFE is reassessing the work plan to complete the investigation of the “JEEP I pit storage”. NRPA has instructed IFE to build a new storage facility for the JEEP I spent fuel.

IFE has also started the visual inspection of the first charge of the HBWR spent fuel stored horizontally in the fuel storage building at HBWR. The method used for the inspection is video inspection to determine the condition of the spent fuel inside the storage pipes.

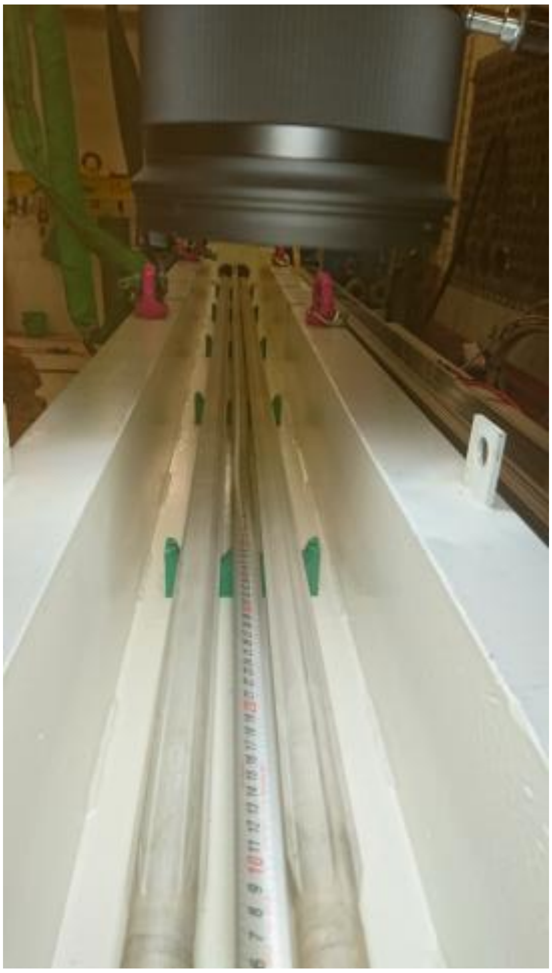


Figure G-2: The visual inspection equipment for the historical spent fuel at HBWR

The preliminary results of the inspections show that most of the fuel elements at HBWR storage building are in an adequate condition. However, traces of corrosion are found on some storage pipes. The work is still in progress by IFE and final results will be presented to NRPA on the completion of investigation campaign. NRPA has identified the need for extra spent fuel storage at the HBWR storage building. Therefore, IFE has been instructed to extend the capacity of the spent fuel storage at Halden.

## Article 6. Siting of proposed facilities

No definitive proposals have been made for the spent fuel management facility in Norway at present. However, the Directorate of Public Construction and Property (Statsbygg) is currently preparing an analysis of the locations and related concept design proposals for a new KLDRA repository for LILW and interim storage for spent fuel.

## 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.

*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. 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.

At present, the operational limits and conditions (OLCs) and the operation and maintenance of the spent fuel facilities are considered as part of the operation of the reactor plants, regulated through the operating licence of the IFE nuclear facilities. The licence has been granted on the basis of the submitted safety analysis reports. NRPA performs inspections to ensure that OLCs and operation, monitoring and maintenance are in accordance with the licensing 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 are developed and updated during the licence period. In the case of a new facility, plans for decommissioning would be required at the planning stage.

In the proposal for the 2018 state budget the Norwegian Government recently proposed establishing a national waste management organization in 2018 and fully operational within 2021.

*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 as recommendations from the government appointed concept evaluation studies (KVUs) and quality assurance studies (KS1) of the KVUs. The favoured option based on these studies is the direct geological disposal of the stable spent fuel, and reprocessing of the unstable spent metallic fuel in aluminium clad.

The history of the government appointed committees for the management of the spent nuclear fuel started in 1999 in Norway. A governmentally appointed committee – *The Bergan committee* – made recommendations for a further strategy regarding the management of spent fuel (NOU 2001:30). The *Bergan 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. 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 *Bergan committee* a study was performed in 2004 on possible technological solutions for the 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 would need 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.*

In 2013, the Ministry of Industries and Fisheries (NFD) started two concept evaluation studies on the recommendations of the Ministry of Finance (FIN), regarding the Norwegian nuclear facilities decommissioning and handling / storage of the spent fuel and radioactive waste. Following two selection study reports (KVUs) were prepared:

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.

The report on spent fuel management studied the following five alternative strategies:

Reference alternate: Continued storage of spent fuel at Kjeller and Halden

Alternate 1: Storage of spent fuel at one location in Norway

Alternate 2: Repository in Norway

Alternate 3: International cooperation concerning international repository

Alternate 4: Reprocessing of all spent fuel.

Alternative 2 and 3 requires that unstable spent fuel must be stabilized through reprocessing. Based on the alternative analysis the KVU concluded on recommending the Alternative 4, under the assumption that one or both reactors are shut down over the next few decades. Moreover, it is also assumed that reprocessing may be accepted by all the authorities in Norway.

The detailed report and its recommendations are public and can be found on government’s website [KVU1, KVU2]

According to the guidelines set by the FIN, the project has gone under the third party quality assurance process, called KS1 [KS1]. On the matter of spent fuel management, the KS1 group reached a conclusion of adopting the Alternative 2 ahead of Alternative 4, as described above.

Both KVU’s and KS1 recommended the increase in the repository capacity of low- and intermediate-level waste (LILW).

The government has started a pre-project to act on the recommendations of the above mentioned KVU’s and KS1 reports.

It was concluded that the estimated amount of radioactive waste will surpass the disposal and storage capacity of the KLDRA facility in Himdalen around 2030. Therefore, it was recommended by the KVU to either extend the existing KLDRA facility or construct a new Combined Disposal and Storage Facility in the near future.

# 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 Management Facility

The Radioactive Waste Management Facility was built in 1959. Before that, the radioactive waste was packed 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 LILW generated by Norwegian industry, hospitals, universities, research organisations and military forces. However, low-level waste containing only naturally radioactive nuclides (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 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 before transportation to the repository in Himdalen.

### H.4 Combined Disposal and Storage Facility at Himdalen (KLDRA)

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 drums 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 $m^3$ (approximately 10,000 210-litre drums). It has been pointed out in KVUs and KS1 that the LILW generated due to decommissioning of the nuclear facilities at Kjeller and Halden, a new KLDRA repository is required in the near future. This new KLDRA facility can either be localized on the existing KLDRA facility in Himdalen by extending its capacity or on a new location. It is recommended to the government, that the process for this work should be started as soon as possible.

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 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 milli man-Sievert. 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 JEEP I reactor. In accordance with the same parliamentary decision, these drums have been placed in the storage hall of the KLDRA facility in Himdalen.

## H.6 Environmental Clean-up

In 1970, 997 drums of LILW, and 19 contaminated objects such as disused liquid waste containers, were disposed of at the IFE site at Kjeller. The drums and objects 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 in 2001 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 radioactive waste, 166 drums containing ca. 35 grams of plutonium, are stored in the KLDRA facility in Himdalen.

In 1974, 1800 kg of contaminated sediments were removed from the riverbed. It was assumed that the sediments contained about 204 MBq Pu-239. These sediments were treated as radioactive waste.

In the early spring of 2000, IFE at Kjeller removed from the bed of the nearby Nitelva River approx. 180 $m^3$, 45 containers, 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 MNOK.

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 MNOK.

*Article 13. Siting of proposed facilities*

Keeping in mind the future decommissioning of the Norwegian nuclear facilities it has been pointed out by KVUs that the reported combined waste volumes from the future decommissioning projects exceed the available disposal volumes at KLDRA in Himdalen. This discrepancy is increasing continuously, as additional waste is being generated each year. The KVU concluded that a new KLDRA repository for the disposal of LILW waste is needed either in the form of a new KLDRA facility or the extension of existing KLDRA facility in Himdalen.

The need of new KLDRA facility for the disposal of LILW waste is further verified in the KS1 reports submitted to the NFD. The Directorate of Public Construction and Property (Statsbygg) is currently preparing a localization analysis and related concept design proposal for a new KLDRA facility and interim storage for the spent fuel.

*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.

*Article 15. Assessment of safety of facilities*

The Combined Disposal and Storage Facility (KLDRA) for the disposal of LILW in Himdalen was put in operation in 1999. The licence for construction was given to the "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 until 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), 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 apart from small amounts from experimental work. Experimental nuclear fuel as test specimens are imported from participants in the OECD Halden Reactor Project, or from bilateral research programmes, for 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 20 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 (16.12.2016) specify the regulatory aspects of handling radioactive sources except waste handling, which is covered by the Pollution Control Act and the regulations on waste. 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, 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 below the regulation exemption levels.

NRPA maintains electronic records of sealed sources above exemption levels, like sources used in 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 notifications to NRPA directly on the web. Owners and users are also able to register, check and verify the information associated with their enterprise.

Starting with the entry into force of the Radiation Protection Regulations of 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, lease or use sealed sources, it is with the requirement that disused sources are to be returned to the manufacturer. However, if no viable options for a license holder in Norway are available, 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 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.

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 fifteen years. The customs have portable measuring equipment across the country. Some 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

During the fifth review meeting of the Joint Convention, 2015, following challenges and suggestions were identified for Norway

Challenges:

- Long-term management of spent fuel and radioactive waste
- Establishment of a radioactive waste management organisation

Suggestion:

- A decision on a national strategy on the disposal of spent fuel and radioactive waste should be taken.

The government of Norway has started a process of long-term management of spent fuel and other radioactive waste through concept selection studies (KVUs), and quality assurance reports of the KVUs (KS1). The main conclusions were to build a new repository in Norway for LILW, secure adequate storage capacity for spent fuel, establish a national waste management organization and to reprocess all the spent fuel. The government is following the recommendations of the reports through consultation with the stakeholders. The results from these processes will form the basis for a national strategy for the disposal of spent fuel and radioactive waste.

Furthermore, to ensure short-term safety of spent fuel management, IFE has been instructed by the NRPA to further investigate the storage conditions of all the metallic spent fuel. It is observed that the storage condition of the metallic spent fuel has been deteriorated. Consequently, IFE has been instructed by the NRPA to build a new storage facility for spent fuel at Kjeller.

At the Halden site, IFE is making progress in monitoring the condition of the spent metallic fuel. The NRPA has instructed IFE to extend the storage capacity for spent fuel at the Halden site.

In the proposal for state budget the Norwegian Government recently proposed establishing a national waste management organization in 2018 and fully operational within 2021. The national waste management organization will be responsible for decommissioning of the nuclear facilities in Norway and waste management.

The license for the HBWR in Halden was renewed in 2015 until December 2020. The license for the JEEP II reactor expires in December 2018. An application for the renewal of operational license of the JEEP-II reactor and other facilities at Kjeller site has been submitted to the HoD by IFE in December 2016. The NRPA is currently reviewing the licence on behalf of HoD. The final decision will be made by HoD on the recommendations of the NRPA during the first quarter of 2018.

International peer reviews:

- In October 2017 an INSARR mission was conducted for the JEEP II reactor, including the JEEP I fuel pit storage. The final report of the mission is pending as of today. A follow-up mission is planned for 2018.
- An IRRS misssion, planned March 2019, has been requested by the NRPA.

All the international peer reviews results will be made public once available.

# 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
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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).

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http://www.regjeringen.no/pages/15663778/PDFS/NOU201120110002000DDDPDFS.pdf

KUV1: The future decommissioning of the nuclear reactors in Norway (in Norwegian) (https://www.regjeringen.no/contentassets/9ed6b7a312ea48c6a2b6705d1fcd82c3/kvu-dekommisjonering-rapport-og-vedlegg-5-11.pdf).

KVU2: The handling of Norwegian Spent Fuel and other Radioactive Waste (in Norwegian) (https://www.regjeringen.no/no/dokumenter/oppbevaring-av-norsk-radioaktivt-avfall/id2365157/).

KS 1: Quality assurance of the future decommissioning of the nuclear reactors in Norway (in Norwegian) (https://www.regjeringen.no/contentassets/73601c56109e4bcf9a2dab33df2c0a90/rapport-ks1-fremtidig-dekommisjonering-av-de-nukleare-anleggene-i-norge.pdf) and the handling of Norwegian spent nuclear fuel and other radioactive waste (in Norwegian) (https://www.regjeringen.no/contentassets/3184f416f1ec443083d69e7a8e711706/rapport-ks1-oppbevaring-av-norsk-radioaktivt-avfall.pdf).