Future decommissioning of Norwegian research reactors

Marte Varpen Holmstrand

Risø, 09.10.2018

Statens strålevern
Norwegian Radiation Protection Authority

www.nrpa.no

Future decommissioning at a glance

- IFE has ongoing decommissioning plans and need to develop final decommissioning plans for Halden

- Financing of decommissioning:
  - The Government will partly finance the decommissioning cost.
  - IFE was instructed to establish a decommissioning fund for the IFE facilities (300 K€/year) some years back.

- Concept study: new repository + no restrictions on use after decommissioning

- Norwegian Nuclear Decommissioning (NND)
  - NND has been established in 2018 under the Ministry of Trade, Industry and Fisheries
  - Will be responsible for decommissioning of nuclear facilities.

Future decommissioning at a glance

- IFE has ongoing decommissioning plans and need to develop final decommissioning plans for Halden

- Financing of decommissioning:
  - The Government will partly finance the decommissioning cost.
  - IFE was instructed to establish a decommissioning fund for the IFE facilities (300 K€/year) some years back.

- Concept study: new repository + no restrictions on use after decommissioning

- Norwegian Nuclear Decommissioning (NND)
  - NND has been established in 2018 under the Ministry of Trade, Industry and Fisheries
  - Will be responsible for decommissioning of nuclear facilities.

Future decommissioning at a glance

- IFE has ongoing decommissioning plans and need to develop final decommissioning plans for Halden

- Financing of decommissioning:
  - The Government will partly finance the decommissioning cost.
  - IFE was instructed to establish a decommissioning fund for the IFE facilities (300 K€/year) some years back.

- Concept study: new repository + no restrictions on use after decommissioning

- Norwegian Nuclear Decommissioning (NND)
  - NND has been established in 2018 under the Ministry of Trade, Industry and Fisheries
  - Will be responsible for decommissioning of nuclear facilities.

Future decommissioning at a glance

- IFE has ongoing decommissioning plans and need to develop final decommissioning plans for Halden
- Financing of decommissioning:
  - The Government will partly finance the decommissioning cost.
  - IFE was instructed to establish a decommissioning fund for the IFE facilities (300 K€/year) some years back.
- Concept study: new repository + no restrictions on use after decommissioning
- Norwegian Nuclear Decommissioning (NND)
  - NND has been established in 2018 under the Ministry of Trade, Industry and Fisheries
  - Will be responsible for decommissioning of nuclear facilities.

Norwegian Radiation Protection Authority

- 1993 – Norwegian Radiation Protection Authority as independent regulatory body
  - 125 employees

- Responsible for; nuclear safety and security, environmental & radiation protection, emergency preparedness & response.

- Authority
  - Pollution control act
  - Nuclear energy act
  - Radiation protection act

Institute for Energy Technology (IFE)

- Independent research foundation
  - Staff ~ 550

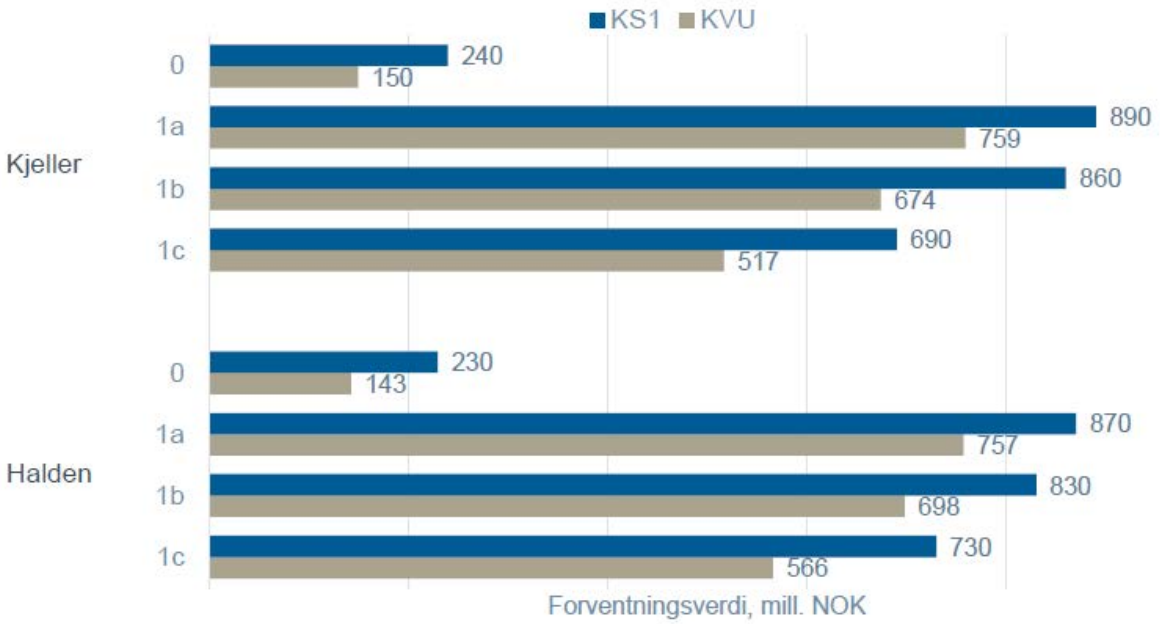
- 1959 – HBWR, 25 MW (Halden)
  - Operational license expires in Dec. 2020
    - Permanently closed and to be decommissioned
    - OECD Halden Project
    - Material science research
    - High burn-up fuel performance

- 1966 – JEEP II, 2 MW (Kjeller)
  - Operational license expires in Dec. 2018
    - In re-licensing process
    - Production of isotopes
    - Neutron Transmutation Doping (NTD) of silicon

Decommissioning end state and cost estimation

Decom End-state

Controlled area	Uncontrolled area
0 = No new use	1A = Green field
1C = Nuclear industry	1B = Non-nuclear industry
3 = Entombment	



Recommendation of the Concept study:
Immediate dismantling to “Green field”.

Decision to decommission

- IFE proclaimed in june 2018 that HBWR (closed due to technical faults) was not going to start up again and will be decommissioned

NYHETER IFE NÆRINGSLIV

Slutt for Haldenreaktoren

Decommissioning plans

- Decommissioning plans of 2016 not sufficient compared to Norwegian regulations, GSR part 6 and WS-G-2.1
- New plans delivered 2018 and is partially part of a relicensing process of the Kjeller facility
- Halden needs a new license from 2020
- Challenging for both operator and regulator going from operations to transition phase
  - Economical and human resources
  - Keeping and aquiring competence
  - Interpretation of relevant regulations and international standards and provide guidance
    - Communication

Previous experience

- In the 60’s two research reactors, JEEP and NORA was decommissioned to brown field
- In the 60’s, the only act that regulated use of radiation, discharges and so on, was the Act on Use of X-Rays from 1938.
  - Irradiation of patients

Legal Framework

- **Act No. 28 (12 May 1972) on Nuclear Energy Act**
  - Regulations No. 1809 (2 November 1984) on Physical Protection of Nuclear Material and Nuclear Installations
  - Regulations No. 433 (12 May 2000) on possession of nuclear material and use of equipment

- **Act 13 March 1981 concerning Protection against Pollution and Concerning Waste (Pollution Control Act)**
  - General regulations (1 June 2004) on the waste management, chapter 16 on radioactive waste.
  - Regulations, 1 Nov. 2010 on the application of the Pollution Control Act on Radioactive Pollution and Radioactive Waste

- **Regulation 22 June 2017 concerning Regulations on impact assessments**

Legal Framework

- **Act No. 28 (12 May 1972) on Nuclear Energy Act**
  - Regulations No. 1809 (2 November 1984) on Physical Protection of Nuclear Material and Nuclear Installations
  - Regulations No. 433 (12 May 2000) on possession of nuclear material and use of equipment

- **Act 13 March 1981 concerning Protection against Pollution and Concerning Waste (Pollution Control Act)**
  - General regulations (1 June 2004) on the waste management, chapter 16 on radioactive waste.
  - Regulations, 1 Nov. 2010 on the application of the Pollution Control Act on Radioactive Pollution and Radioactive Waste

- **Regulation 22 June 2017 concerning Regulations on impact assessments**

Radioactive waste

- Regulations, 1 Nov. 2010 on the application of the Pollution Control Act on Radioactive Pollution and Radioactive Waste

If the waste contains various nuclides the waste is to be considered radioactive if the sum of the ratio between specific activity for each radionuclide and the corresponding value in the table is greater than or equal to 1:

$$\sum_k \frac{C_k}{C_{e,k}} \geq 1$$

where

C_k = specific activity for radionuclide k

C_e, k = limit value for specific activity of radionuclide k from the table.

Radionuclide	*Specific activity (Bq/g)*
H-3	10^2
Be-7	10^1
C-14	10^1
O-15	10^2

Radionuclide	*Specific activity (Bq/g)*
Ca-45	10^2
Ca-47	10^1
Sc-46	10^{-1}
Sc-47	10^2

Radionuclide	*Specific activity (Bq/g)*
Co-57	10^0
Co-58	10^0
Co-58m	10^4
Co-60	10^{-1}

The values in the table show specific activity (Bq/g), and the total activity (Bq) per year, for what is considered waste subject to a disposal requirement; see section 2 letter d. To define waste subject to a disposal requirement both total activity and specific activity has to be greater than or equal to the values. It is the activity's expected total waste in the course of a year on which the activity shall base its assessment of the deposition requirement. If the waste contains various nuclides, the waste is subject to a disposal requirement if the sum of the ratio between specific activity for each radionuclide and the corresponding value in the table, and the sum of the ratio between (total) activity for each radionuclide and the corresponding value in the table, is greater than or equal to 1:

$$\sum_k \frac{C_k}{C_{e,k}} \geq 1 \text{ and } \sum_k \frac{A_k}{A_{e,k}} \geq 1$$

where

C_k = specific activity for radionuclide k

C_e, k = limit value for specific activity of radionuclide k

A_k = activity for radionuclide k

A_e, k = limit value for activity of radionuclide k.

Radionuclide	*Total activity (Bq) per year*	*Specific activity (Bq/g)*
H-3	10^9	10^6
Be-7	10^7	10^3
C-14	10^7	10^4
O-15	10^9	10^2

Legal Framework

- **Act No. 28 (12 May 1972) on Nuclear Energy Act**
  - Regulations No. 1809 (2 November 1984) on Physical Protection of Nuclear Material and Nuclear Installations
  - Regulations No. 433 (12 May 2000) on possession of nuclear material and use of equipment

- **Act 13 March 1981 concerning Protection against Pollution and Concerning Waste (Pollution Control Act)**
  - General regulations (1 June 2004) on the waste management, chapter 16 on radioactive waste.
  - Regulations, 1 Nov. 2010 on the application of the Pollution Control Act on Radioactive Pollution and Radioactive Waste

- **Regulation 22 June 2017 concerning Regulations on impact assessments**

Repositories and waste handling

- Without the precense of radionuclides and the following need for proper radioactive waste handling and special repositories, decommissioning would not be significantly different from ordinary demolition of houses.
- Proper waste handling, construction and operation of safe repositories are cornerstones in decommissioning (together with radiation protection, which is an issue for the entire lifetime)
- Repositories are expensive
- No need to fill them with non-radioactive waste
- But all radioactive waste must be handled propertly (i.e. sent to a repository)

Repositories and waste handling

- Without the precense of radionuclides and the following need for proper radioactive waste handling and special repositories, decommissioning would not be significantly different from ordinary demolition of houses.
- Proper waste handling, construction and operation of safe repositories are cornerstones in decommissioning (together with radiation protection, which is an issue for the entire lifetime)
- Repositories are expensive
- No need to fill them with non-radioactive waste
- But all radioactive waste must be handled propertly (i.e. sent to a repository)

Technical challenges

- How can we make sure that all radioactive waste is identified and properly handled?
- How do we make sure that no non-radioactive waste is sent to a repository?
- Measurements
  - From Bq/cm2 to Bq/g?
  - DTM + heterogenous distribution and depth of radionuclides.
  - Measurements in bulk volumes
- Other treatments

Technical challenges

- How can we make sure that all radioactive waste is identified and properly handled?
- How do we make sure that no non-radioactive waste is sent to a repository?
- Measurements
  - From Bq/cm^2 to Bq/g?
  - DTM + heterogenous distribution and depth of radionuclides.
  - Measurements in bulk volumes
- Other treatments

Technical challenges

- How can we make sure that all radioactive waste is identified and properly handled?
- How do we make sure that no non-radioactive waste is sent to a repository?
- Measurements
  - From Bq/cm^2 to Bq/g?
  - DTM + heterogenous distribution and depth of radionuclides.
  - Measurements in bulk volumes
- Other treatments

Technical challenges

- How can we make sure that all radioactive waste is identified and properly handled?
- How do we make sure that no non-radioactive waste is sent to a repository?
- Measurements
  - From Bq/cm^2 to Bq/g?
  - DTM + heterogenous distribution and depth of radionuclides.
  - Measurements in bulk volumes
- Other treatments
  - Melting of metals
  - Decontamination

What if? Not radioactive waste, yet somewhat radioactive??

Repositories

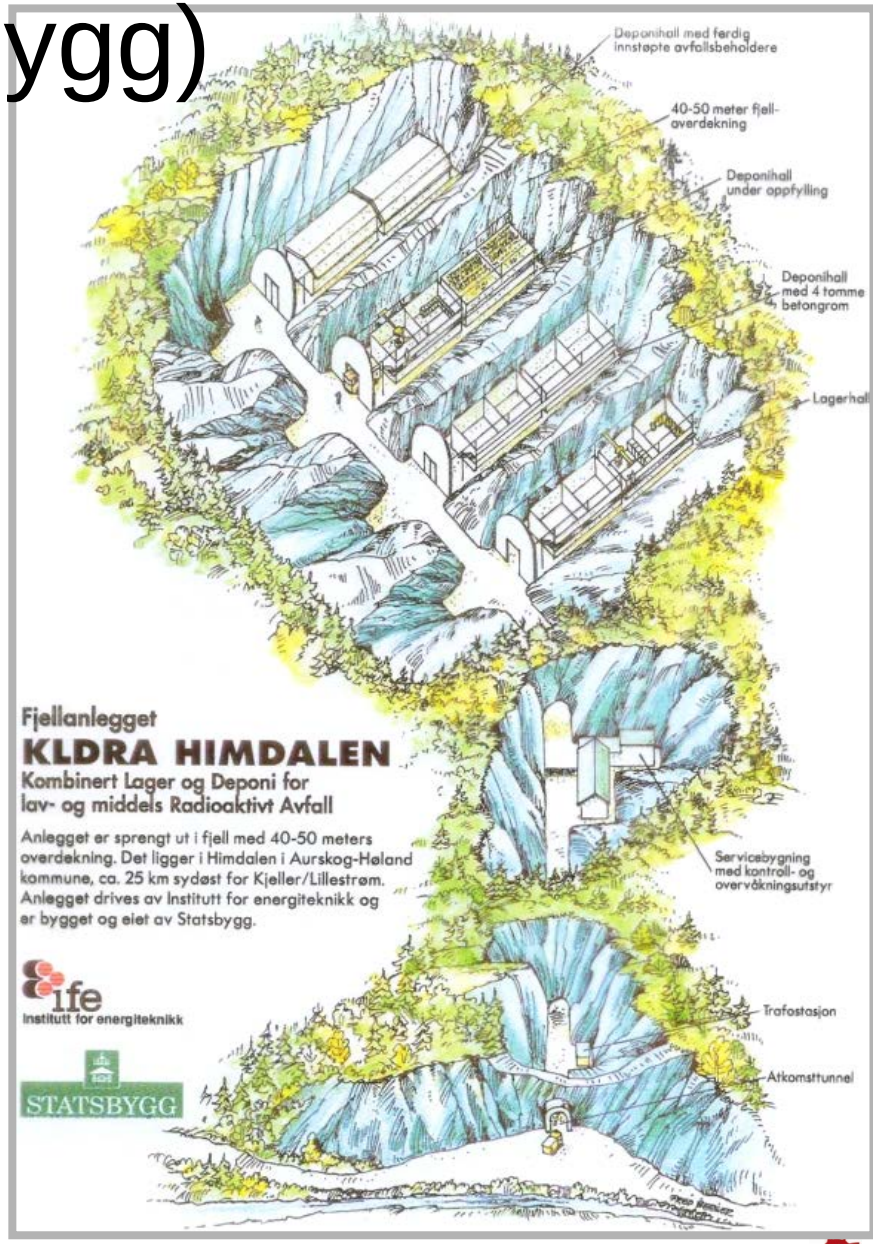
- Norway has five repositories:
  - 3 for NORM rocks (NOAH Langøya, Borge, Heggvin)
  - 1 for NORM from petroleum (Wergeland-Halsvik)
  - 1 for anthropogenic radioactive waste (KLDRA)
- KLDRA – “combined storage and repository” for low level and intermediate level anthropogenic waste accepts wastes from IFE, hospitals, universities, consumer goods
- Can take low- and intermediate level waste from decommissioning
- Capacity too low for accepting decommissioning waste from Halden and Kjeller sites.

Repositories

- Norway has five repositories:
  - 3 for NORM rocks (NOAH Langøya, Borge, Heggvin)
  - 1 for NORM from petroleum (Wergeland-Halsvik)
  - 1 for anthropogenic radioactive waste (KLDRA)
- KLDRA – “combined storage and repository” for low level and intermediate level anthropogenic waste accepts wastes from IFE, hospitals, universities, consumer goods
- Can take low- and intermediate level waste from decommissioning
- Capacity too low for accepting decommissioning waste from Halden and Kjeller sites.

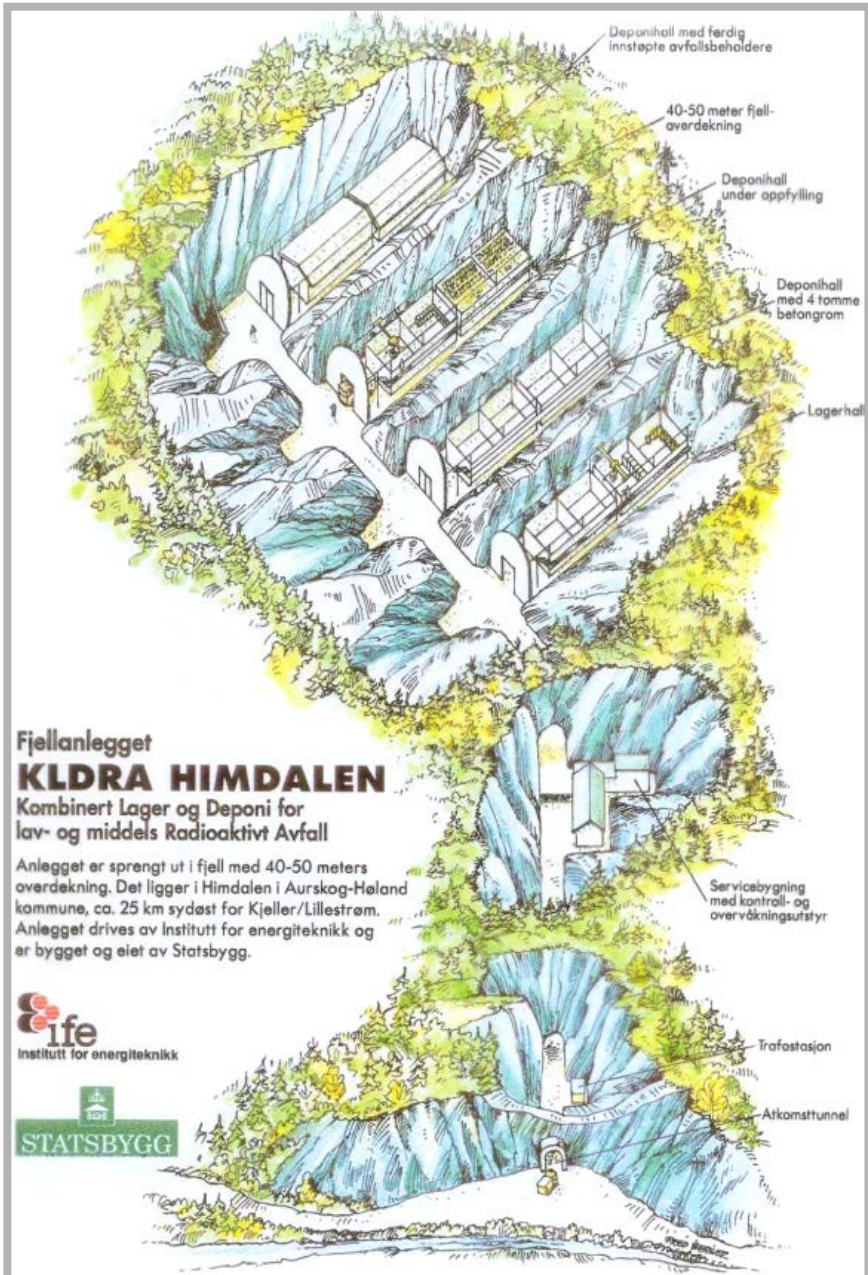
Directorate of Public Construction and Property (Statsbygg)

- State owned organization:
  - State's central adviser in construction and property matters, builder, property manager and property developer.
- Owner of the KLDRA Himdalen
- Future owner of the new KLDRA facility (LILW repository)
- Operated by IFE



Himdalen

- 1998 – LILW facility at Himdalen
  - Operational licence til 2028
- The facility is built in crystalline bedrock
- Total capacity 2000 m^3 (10,000 210 l drums)
- Norwegian Nuclear Decommissioning (NND)
- Ca. 60% filled by volume



Establishment of Norwegian Nuclear Decommissioning

- Norwegian Nuclear Decommissioning (NND) was established by a Royal decree 12. February 2018.
- The NND is established under The Ministry of Trade, Industry and Fisheries (NFD)
- The NND – organization responsible for radioactive waste management and decommissioning
- Fully operative within 2020 – 2021
- Will be regulated and inspected by NRPA

Thank you for your attention. Any questions?

marte.holmstrand@nrpa.no
+4767162509