Inventory of Dry Stored Steel Waste after 25 Years

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Abstract

In the first years of the hot laboratory complete experimental elements were handled and examined at the hot laboratory in Kjeller. Fuel rods were disassembled from the elements in the hot cells and PIE performed. After examination the elements were cut and the fuel and non fuel parts stored separately in stainless steel baskets in a dry pit storage facility of spent fuel at the IFE Hot Laboratory.
Approximately 130 baskets were filled with non fuel parts, most of them from the time between 1970 and 1985. Since the storage capacity is limited it was decided in 1997 to transfer baskets with a radiation level below 30mSv/h measured with 10 cm distance and without fuel to KLDRA, the national Norwegian storage site for low and medium radioactive waste. KLDRA is located in a mountain nearby IFE-Kjeller and was opened in 1998.

Since it was necessary to verify that the baskets do not contain fuel parts, except small amounts of cross contamination, each basket was scanned with a germanium detector with respect to ^{137}Cs and ^{60}Co prior to clarification. Clarified baskets were packed into concrete casks, sealed with concrete and transported to KLDRA. The first batch was clarified and packed in 2001 (altogether 25 baskets), the second batch in 2002 (altogether 34 baskets) and the last batch for the first time will be done in 2003 and it is planed to transfer 27 baskets to KLDRA. This report describes the equipment and the technique used to clarify and transfer those baskets from the dry storage place at Kjeller to the low and medium radioactive waste storage site KLDRA.

Introduction:

The hot laboratory at Kjeller has an intermediate dry storage facility for high active waste, see Fig.1. It was build in 1966 with 32 pits, whereof each can be filled with 6 standard baskets. In 1971 the storage capacity was increased with additionally 52 pits built to accommodate up to 9 standard baskets each. The inner diameter of the cylindrical stainless steel baskets is 80mm and the inner height 900mm. The pits are arranged in 6x15 rows whereof 6 pits positions are blind. For handling purposes an overhead crane is installed in the facility. In a pit three baskets can be placed in the same level and two to three on top of each other, see Fig. 2 and Fig. 3.

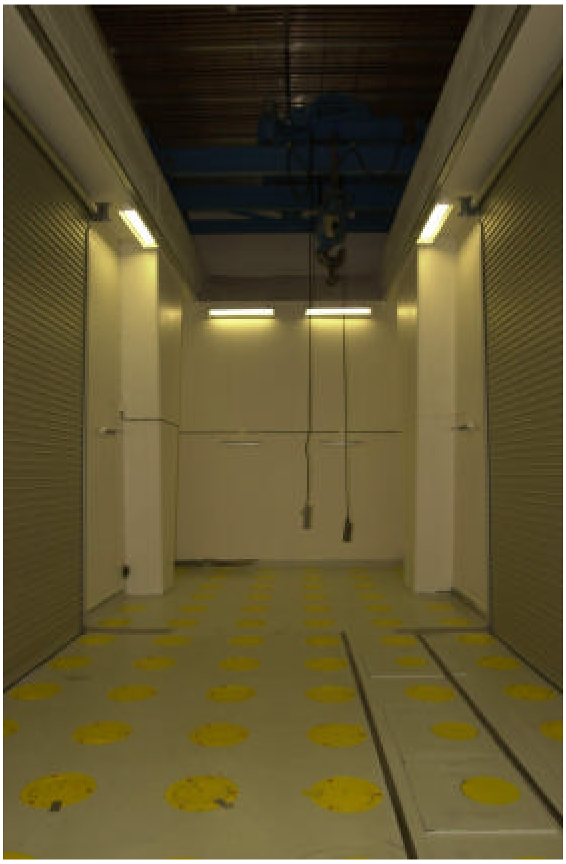

Fig 1: Intermediate dry storage facility for spent fuel

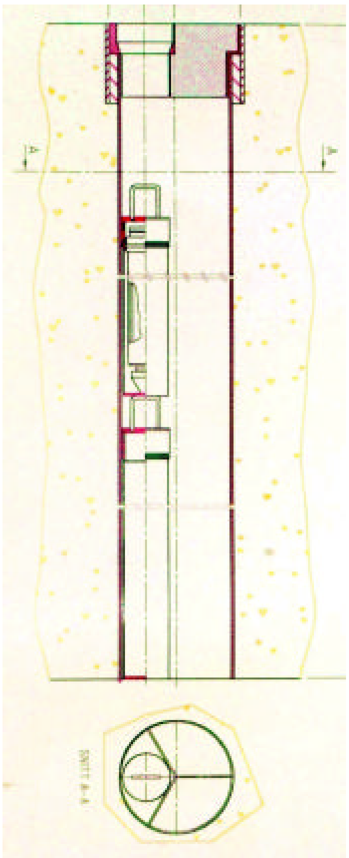

Fig 2: Cross section of a two store pit for six standard baskets

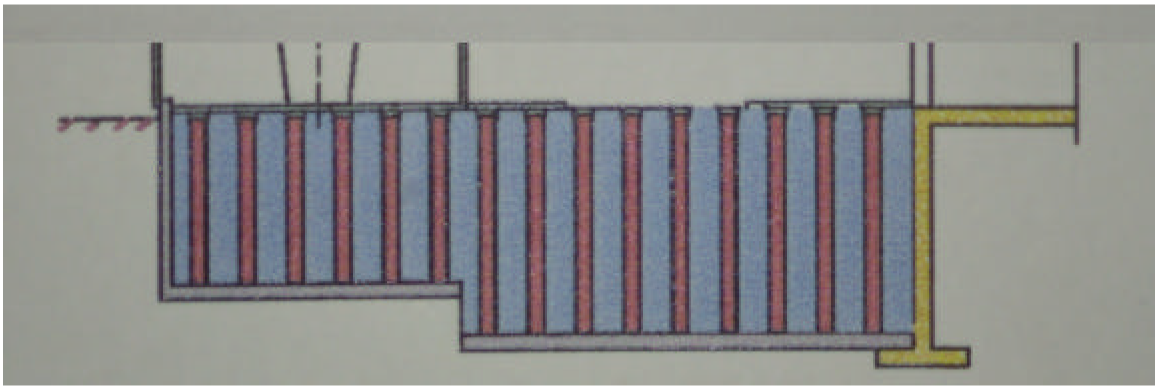

Fig 3: Cross section of the pit store

In 1997 approximately 310 standard and 90 special baskets (for fuel elements, occupying a storage place equal 1.5 standard baskets) were stored. Thereof 130 baskets did not contain fuel, the rest was packed with either complete rods or cut offs.

Due to the storage capacity an evaluation process was started in 1997 to find solutions to increase the storage capacity, such as:

- Extension to the storage facility.
- Compression and repacking of the baskets.
- Removal of baskets not containing fuel and transfer to the national storage site KLDRA.

The last solution with transport to KLDRA was selected.

Experimental

Qualification work

In the period 1966 to 1985 mainly, complete elements were transported to Kjeller for PIE. Fuel rods from these elements were removed and examined while the 'shroud' was cut in parts and stored in the steel baskets in the pit. In 1998, 13 of these baskets randomly were picked up and the radiation level measured at a distance of ca. 10 cm. It varied from 0,3 mSv/h up to 18 mSv/h. After several meetings and discussions with the nuclear waste department and health physics an operational procedure was agreed on. A list of all easy accessible baskets with the location and content was produced.

Final storage casks

Two different types of concrete storage casks were produced. Type I in concrete only and the type II was concrete with 3 cm lead cladding. The aim with the cask and cladding was to limit the outer radiation level at the packed storage casks to 2 mSv/h see Fig. 4.

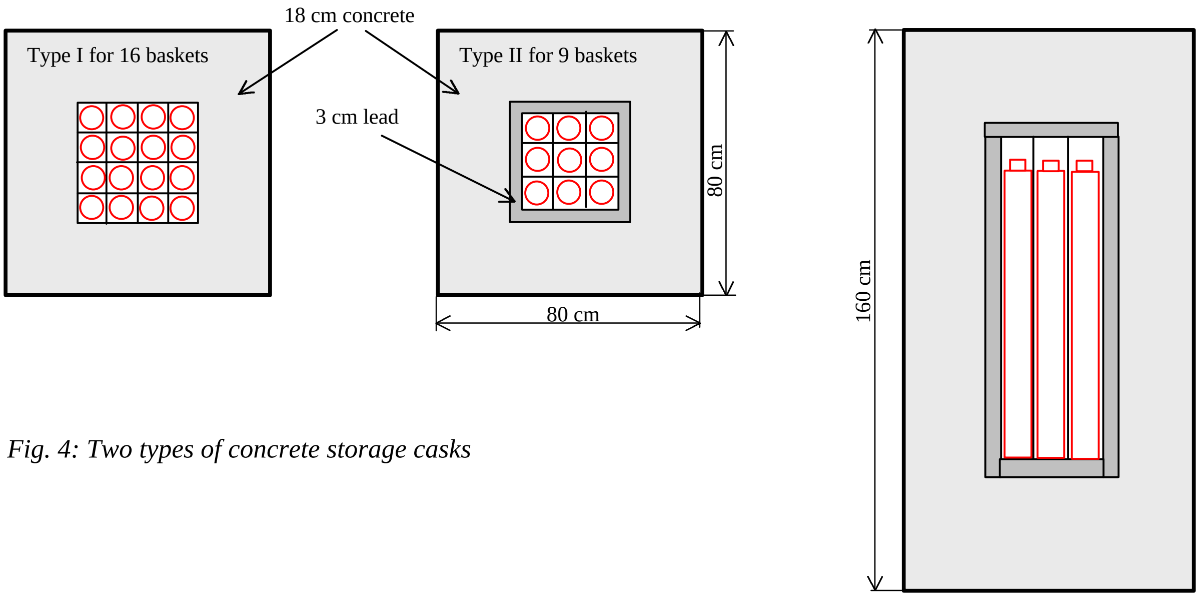

Fig. 4: Two types of concrete storage casks

Selection of baskets for transport to KLDRA

The selected and identified baskets were removed from the storage pits into a shielded transport container. Fig. 5 shows the transport container in position over a pit (a). A flange which is in between the pit and the transport container has an inspection hole (b) allowing radiological measurements. During pulling of the basket from the pit into the transport container the radiation level was continuously measured with an extern probe which was mounted in the inspection hole. After evaluation of the radiation level the basket was either put back to the pit or transported to the measuring station.

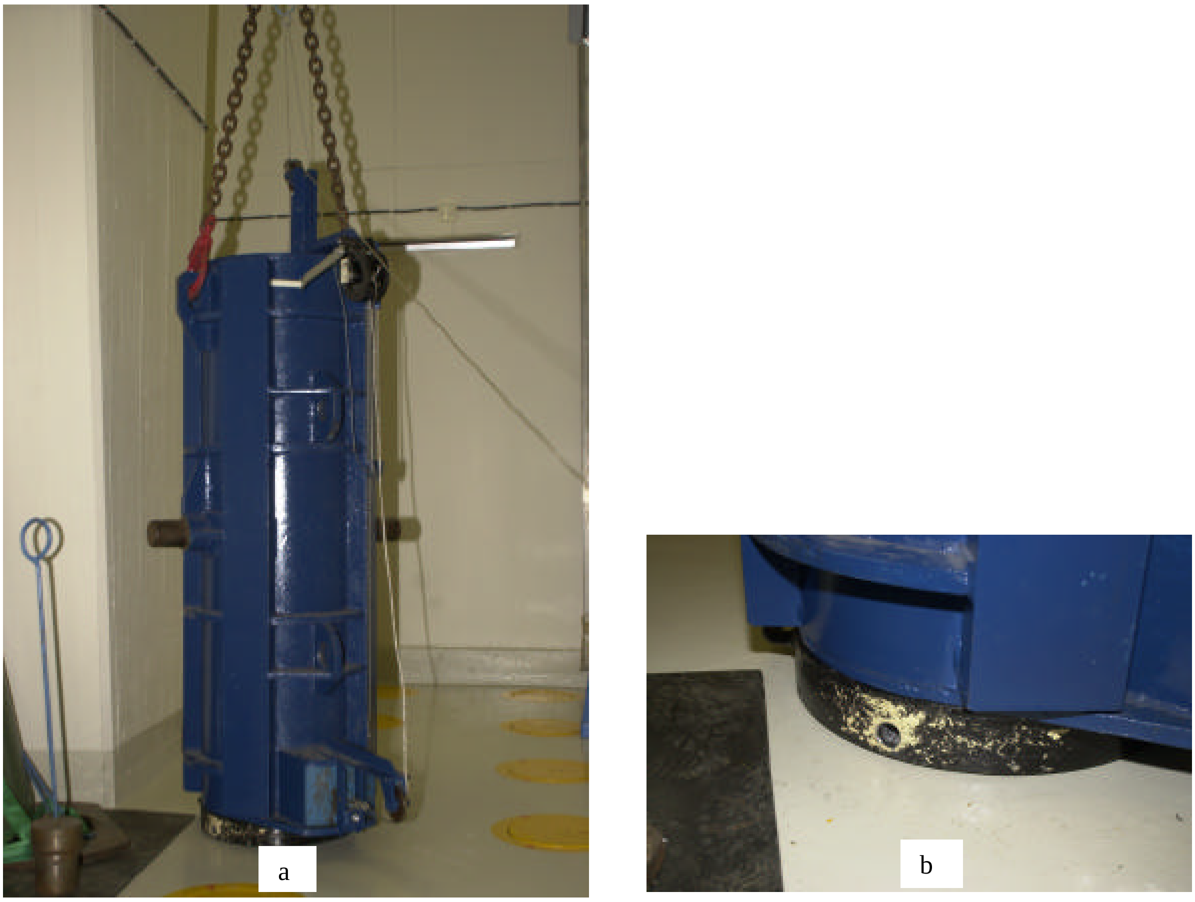

Fig. 5: The transport container for lifting the standard baskets(a) and the inspection hole (b)

Check on basket content by gamma scanning

An overhead crane was used to transfer the transport container with the basket to the measuring station. The equipment and experimental set-up for gamma scanning consists of a lead shielded basket container, a lead shielded collimator and extra lead shielding around the collimator, to reduce background radiation, see Fig. 7 and Fig. 8.

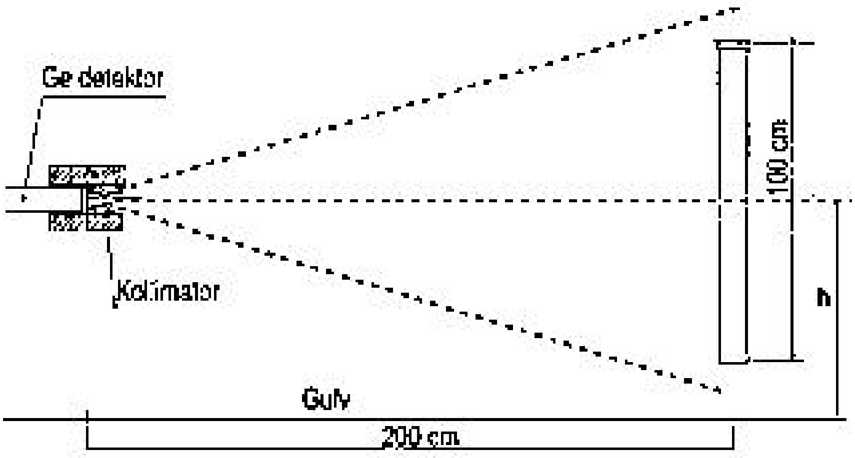

Fig. 6: Germanium detector focusing the basket

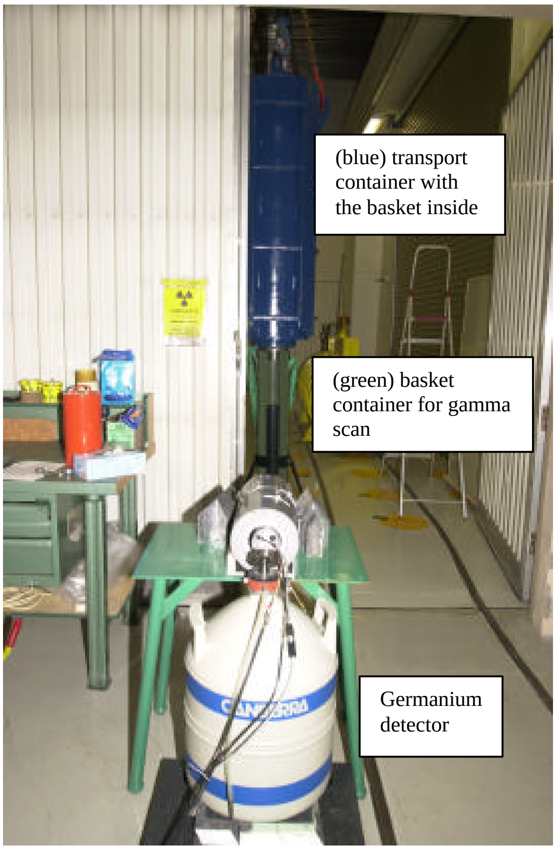

Fig. 7: Experimental set up for the measuring of ^{137}Cs and ^{60}Co with the germanium detector

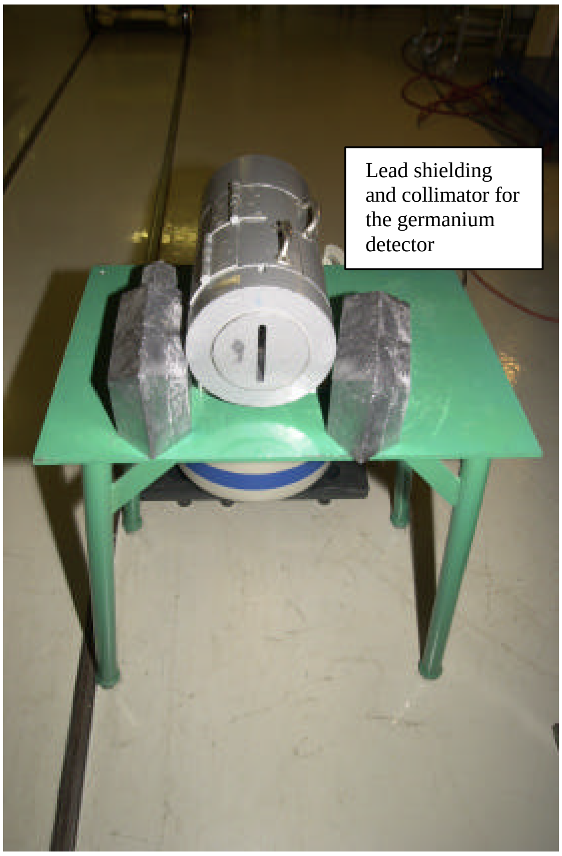

Fig. 8: Shielded collimator for the germanium detector

The basket was immersed into a partly shielded container. This container was open towards the germanium detector and shielded with 4 cm lead for the operators, see Fig. 9 and Fig. 10.

Fig. 9: The measuring arrangement with (blue) transport container and (green) basket container for gamma scan

Fig. 10: Flange between the transport container and the basket container

The germanium detector used for gamma scanning was Canberra model GC2818 with 2048 multichannel analyser. Analysis was performed using interactive computer code MAESTRO. The gamma spectrum has been calibrated – the channel number was set approximately equal to the gamma energy given in keV.
Each basket was scanned and the gamma spectrum has been recorded. The counting time was 100s. The activity of ^{137}Cs and ^{60}Co in the basket was determined by comparison with the activity of sources of ^{137}Cs (3.72 x 10^9 Bq) and ^{60}Co (32.7 x 10^6 Bq), scanned previously and used as the calibration standards. The obtain values have been corrected by applying the correction factors for geometry and shielding. The gradually increasing backgrounds activity was measured and taken into account. A typical scan is shown in Fig. 11.

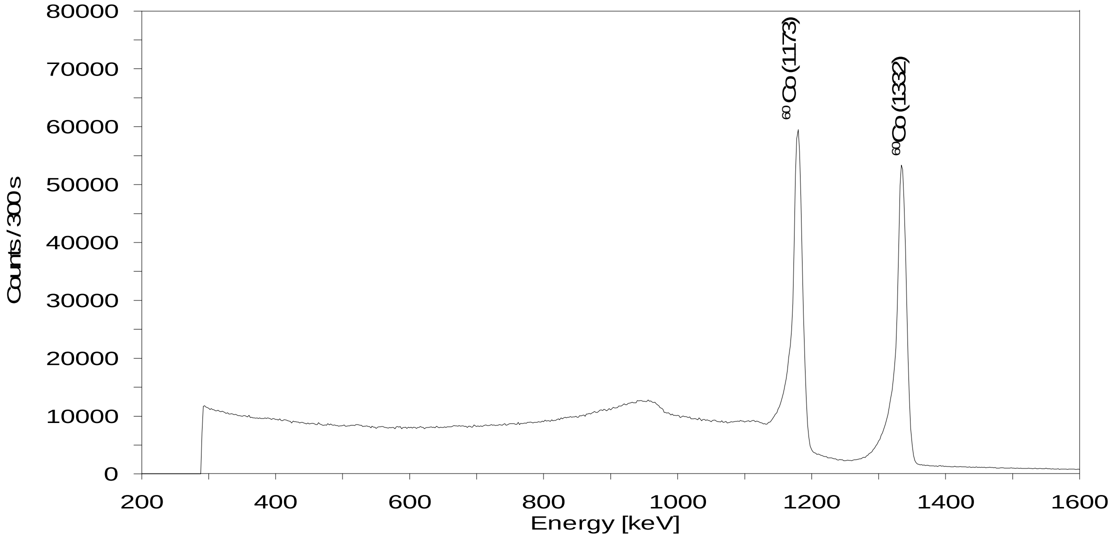

Fig. 11: Gamma spectrum from a typical basket

Packing and sealing of final waste containers

After gamma scanning, the baskets were pulled back into the transport container and transported either back to the pit (depending on the presents of ^{137}Cs) or on top of the concrete casks, see Fig. 12 and Fig. 13. The type and position of the casks was depending on the activity level of the baskets. Baskets with a total activity below 1 GBq ^{60}Co were put into the concrete cask type I (18cm concrete). Baskets with a total activity between 1 GBq and 4.6 GBq ^{60}Co were placed in the cask type II (18cm concrete with 3 cm lead cladding).

Fig. 12: Transport container on top of the concrete cask.

Fig. 13: Concrete cask type II for 9 baskets. 18 cm concrete walls and 3 cm lead cladding

After each insert of a basket into the concrete cask, the outer surface radiation was monitored not to exceed 2mSv/h, otherwise the basket was repositioned or put back into the pit. After packing the concrete casks with baskets, the opening in the top was filled and sealed with steel reinforced concrete. The packed and sealed casks were transferred to the IFE waste department for final storage at KLDRA.

National Norwegian storage site for low and medium radioactive waste (KLDRA)

KLDRA is the national, Norwegian storage site for low and medium radioactive waste, located in a mountain nearby Kjeller, which was opened in 1998, see Fig. 14 and Fig. 15.

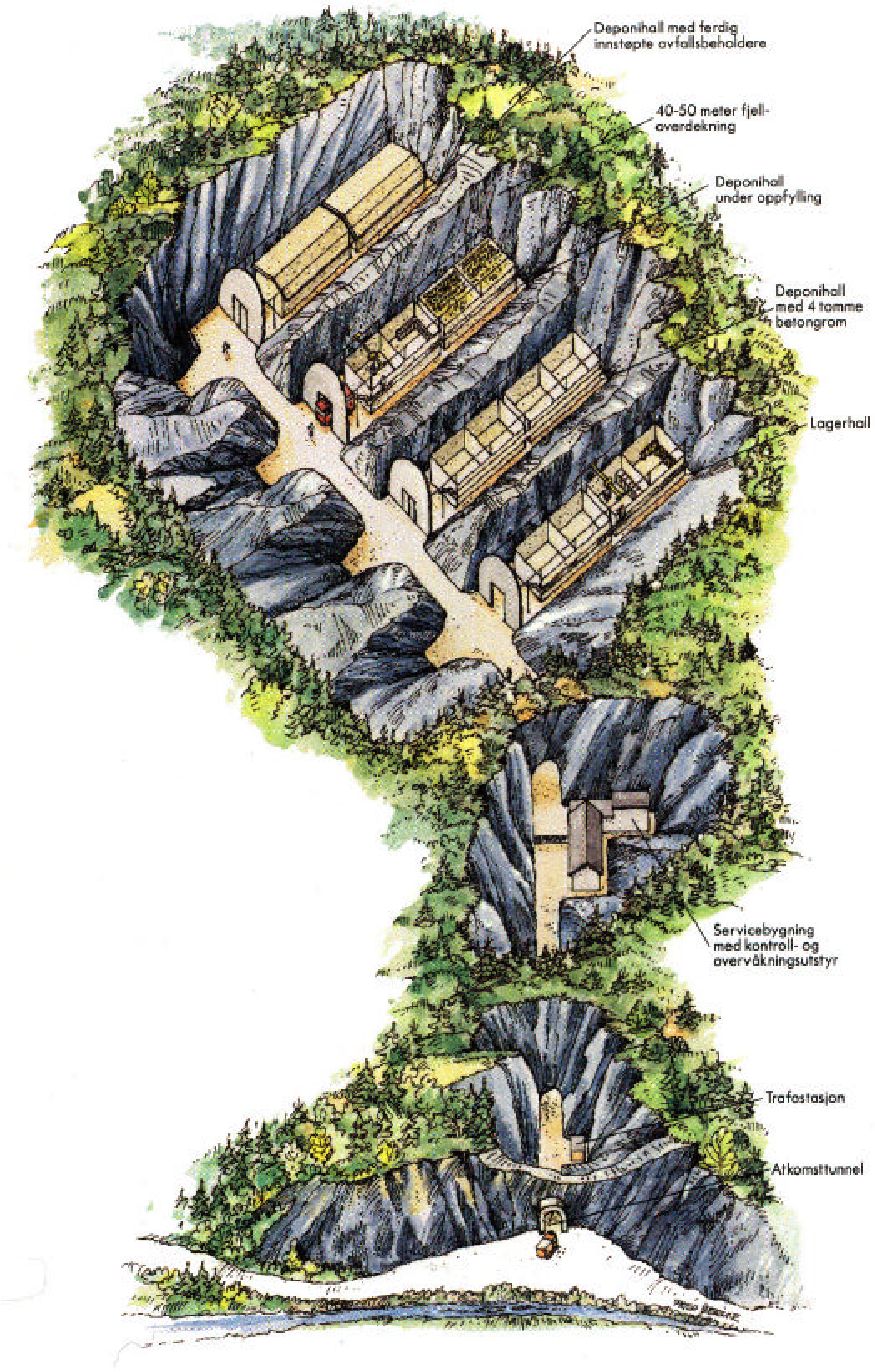

Fig. 14: National mountain storage site for low and medium radioactive waste (KLDRA)

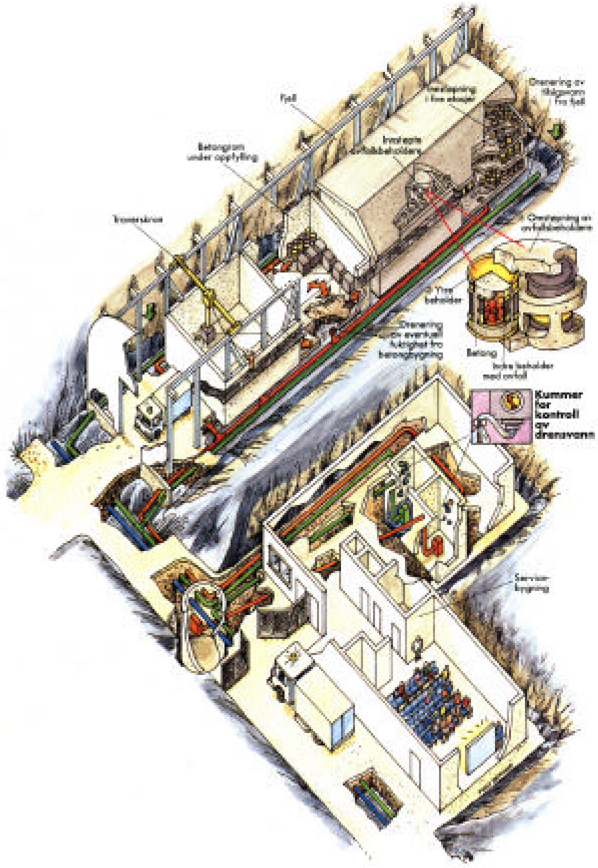

Fig. 15: Supply systems and operations at KLDRA

Conclusion

- The entire process of sending baskets containing more than 20 year old irradiated steel from the pits for spend fuel to KLDRA was initiated in November 1997. The first batch with 25 baskets was packed in November 2001, the second batch with 34 baskets in august 2002 and the third batch with 27 baskets will be done in winter 2003/2004.
- Involved executing personnel was basically, one coordinator, a scientist for gamma scan, three technicians and personnel from the health physic.
- Great care was taken, during planning and executing of the work, to lower the person dose according to the ALARA-principle. The average dose for the involved personnel for the first batch (25 baskets) was 0,3 mSv and the maximum was 0,4 mSv. For the second batch (34 baskets) the average dose was 0,4 mSv and the maximum was 0,7 mSv.
- In average 8 baskets were moved from the pit, measured, scanned and put into the concrete cask per working day. It took roughly 2 weeks per batch from the first scan until the casks were sealed with concrete. The entire handling operation worked smoothly without any interruption.
- Gamma scanning of the baskets proved to be not as demanding as expected, after a appropriate shielding for background radiation was put around the detector.