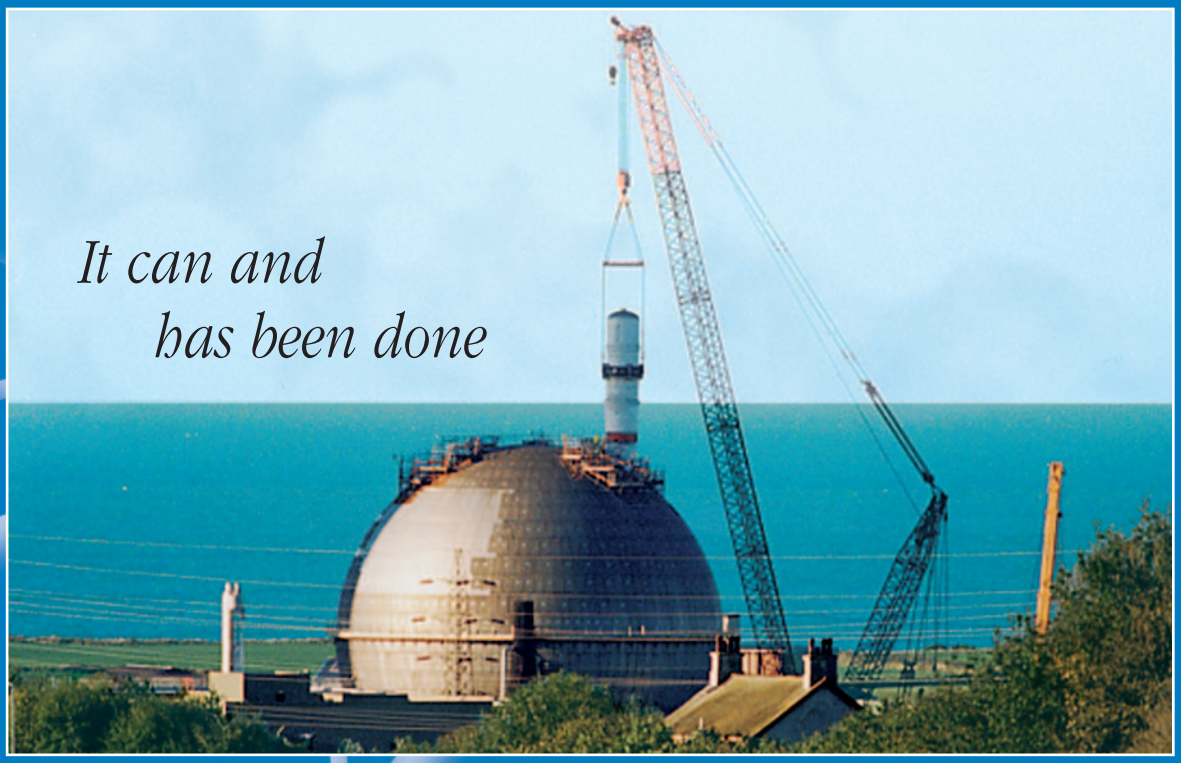
AEN
NEA
2005

Decommissioning of Nuclear Power Facilities



One concern commonly expressed about electricity production from nuclear power is that the decommissioning and dismantling to a desirable end state of the redundant radioactive facilities presents a significant problem. In fact, international experience shows that this is not the case. This brochure looks at decommissioning across the spectrum of nuclear power facilities and shows worldwide examples of successful projects. Further information can be found in NEA publications and on a number of websites (see the back of this brochure).

Brochure produced by the Working Party on Decommissioning and Dismantling (WPDD) and the Co-operative Programme on Decommissioning (CPD) under the aegis of the OECD/NEA Radioactive Waste Management Committee (RWMC).

AEN
NEA

N U C L E A R • E N E R G Y • A G E N C Y

Range of plants needed to generate nuclear energy

The diagram shows the plants commonly involved in electricity generation by nuclear means. Uranium ore is mined to produce fuel for power plants ❶. The ore is processed and converted ❷ to a form which enables enrichment ❸ of one particular type (isotope 235). The enriched material is then fabricated into fuel elements ❹ for use in power plants ❺. The used fuel can either be treated as a waste (direct disposal) or can be reprocessed ❻. In reprocessing, reusable uranium and plutonium is extracted for further use as a fuel ❼.

Result of decommissioning

The bulk of scrap materials arising from most decommissioning projects are not radioactive and can be recycled or sent for conventional disposal. Radioactive materials are packaged and sent to radioactive waste disposal facilities (examples: Centre de l'Aube, France, and El Cabril, Spain) or kept in storage where such facilities are not yet available. The sites of decommissioned facilities can be returned for unrestricted use, industrial reuse or nuclear reuse.

Storage and disposal of decommissioning waste


Centre de l'Aube, France


El Cabril, Spain

Examples of successful decommissioning projects

1 Uranium mining and milling
Beaverlodge, Saskatchewan, Canada

The Beaverlodge Operation had three shafts in the main mine, a large mill near the main production shaft, several small open pit mines and a number of exploration shafts and adits. The decommissioning of the facility was completed in 1985. After a period of monitoring to demonstrate that the decommissioned site is performing as expected, it will be returned to the provincial government.


Before


After

2 Uranium conversion
Korea Atomic Energy Research Institute (KAERI)

Uranium conversion facilities purify and transform uranium ore concentrate for fuel fabrication. The KAERI plant capacity was 100 tonnes of uranium oxide per year. These facilities have many tanks and pipes, which are planned to be released for reuse. Sludge treatment is the largest task faced, because it contains uranium and hazardous chemical materials. Decommissioning planning started in 2001 and the actual dismantling work is being carried out from 2004 to 2007.


Before decommissioning

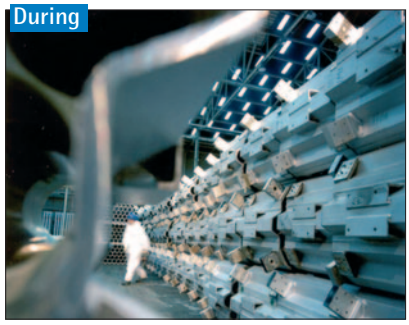

Inside the plant


Decommissioning ongoing

3 Uranium enrichment
Capenhurst, UK

When it was constructed in the 1950s the Capenhurst enrichment plant was the largest building in Europe (1 200 x 150 x 30 m), including large amounts of metals, of which 4 800 diffusion stages and 1 800 km of process gas pipework up to 55 cm in diameter. Extensive decontamination and remelting were employed. Of the 160 000 tonnes of metals and concrete removed, more than 99% were recycled for unrestricted use as clean material. Today the facility is fully decommissioned and the building has been removed.


The facility before decommissioning


During


After

4 Fuel fabrication
Hanau, Germany

Hanau is the site of four German fuel fabrication plants. One of them produced uranium fuel elements for light water reactors (1 350 tonnes/year). A particular challenge is the cleanup of buildings and soil; natural uranium is the major radionuclide present. The site is on industrial premises and will be reused for industrial purposes. Individual facilities and parts of the site were already released from nuclear regulatory control. Termination of all the decommissioning activities is scheduled for 2005. Stores for uranium and plutonium waste will remain on the site awaiting disposal.


The facility before decommissioning

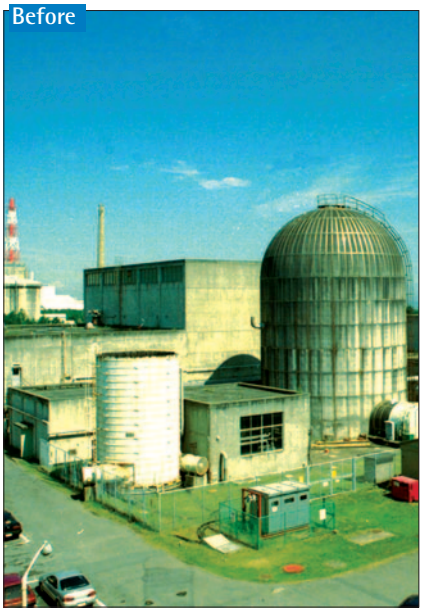

Surface decontamination in progress


After decommissioning, storage

5 Power reactors

Most of the decommissioned reactors concern the earlier and smaller prototype and development plants. A modern nuclear power plant will have a life of about 40 years and most have therefore not reached the point where decommissioning is needed. Some have, and examples are given below of prototype and commercial plants.

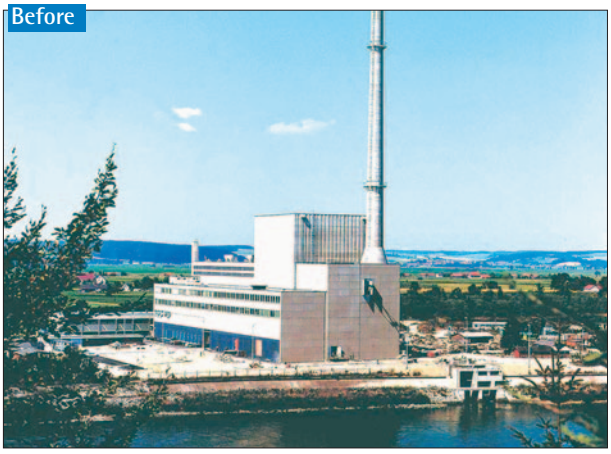
Japanese Power Demonstration Reactor, 10 MWe boiling water reactor. Decommissioning completed in 1996.


Before


During


After

Niederaichbach, Germany, 100 MWe heavy water reactor. Released for unrestricted agricultural use in mid-1995.



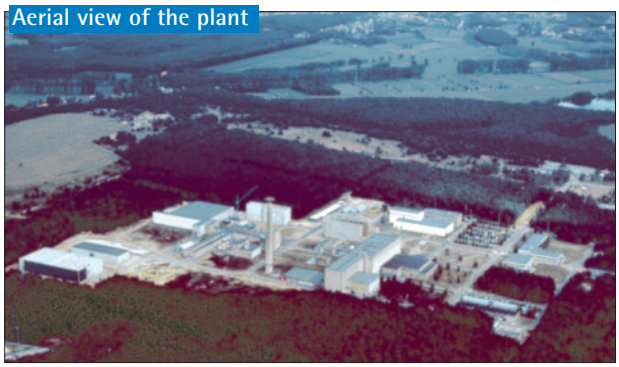
Fort St Vrain, USA, 330 MWe high-temperature gas-cooled reactor. Decommissioning completed in 1992. The former reactor building now contains a gas turbine plant.

Maine Yankee, USA, 900 MWe pressurised water reactor. Decommissioning was completed in 2005.

6 Reprocessing
Eurochemic, Belgium

The dimensions of the main building of the reprocessing plant were 80 x 27 x 30 m. The facility contained 1 500 tonnes of metals and 55 000 m^2 of concrete surface. Some 85% of the metallic materials will have been decontaminated and recycled as clean metal on completion. The decommissioning will be completed in 2008.

Aerial view of the plant



During decommissioning

After decommissioning

(Helmets and coats are used as in regular industrial facilities.)

7 Plutonium fuel fabrication
Winfrith, UK

The active area was an 18 x 12 x 4.5 m steel room containing plutonium handling glove boxes and facilities for fuel fabrication (sintering furnaces, ball mills, grinding machines). It was used for production of fast reactor fuel and also high-temperature reactor fuel. Decommissioning was carried out between 1996 and 1999 and the site was restored to green-field condition.

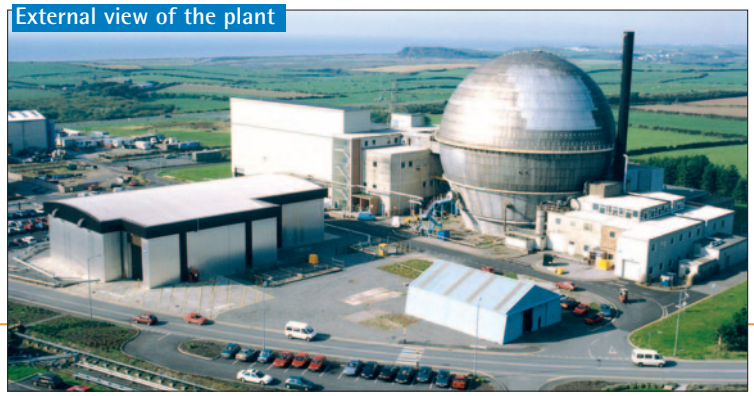
The plant during operation

Demolition of the decontaminated building shell

After decommissioning

A closer look inside an ongoing project

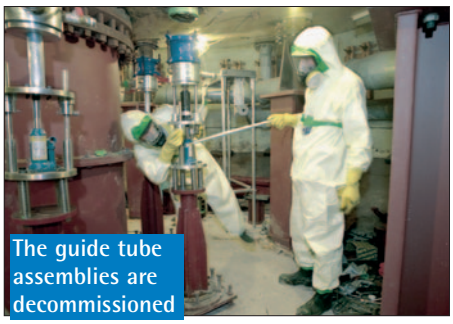
Windscale advanced gas-cooled reactor decommissioning, UK



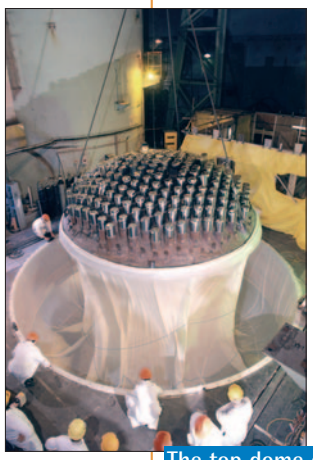
External view of the plant

Size reduction of the top part of the biological shield

Four heat exchangers lifted out through the roof, 100 tons each (see also front cover)



The guide tube assemblies are decommissioned



The top dome of the reactor is cut off and lifted away, using a containment bag

Packaged decommissioning waste in storage

Other examples of advanced, large reactor decommissioning projects are:

– Würgassen, 670 MWe pressurised water reactor, Germany.
– Trojan, 1 180 MWe pressurised water reactor, USA.
– Connecticut Yankee, 582 MWe pressurised water reactor, USA.

Many other decommissioning projects are ongoing or are in an advanced planning stage.

Decommissioning of other types of facilities

Commercial plants have been decommissioned; there are also many examples of decommissioned research facilities, laboratories, isotope production facilities, accelerators and historical facilities such as plants utilising radium sources to build fluorescent watch dials, etc.

Conclusion

This brochure demonstrates, via successful decommissioning projects from across OECD countries, that decommissioning of the full range of nuclear power production facilities can, and has been achieved. The end states are green field, industrial reuse or conventional use of sites and buildings.

Further information on decommissioning:

Examples of international websites on decommissioning:

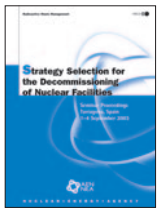
Publications from the Working Party on Decommissioning and Dismantling (WPDD) and national fact sheets:
www.nea.fr/html/rwm/wpdd.

International organisations:
www-newmdb.iaea.org
http://europa.eu.int/comm/energy/nuclear/decommissioning/index_en.htm

Industrial links:
www.world-nuclear.org/wgs/decom/index.htm
www.nei.org/doc.asp?catnum=3&catid=278

NEA publications on decommissioning (as of September 2005):

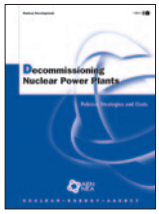
neapub@nea.fr



Strategy Selection for the Decommissioning of Nuclear Facilities
Seminar Proceedings, Tarragona, Spain
1-4 September 2003
ISBN 92-64-01671-6 – 2004
Price: € 60, US$ 75, £ 42, ¥ 7 700.

The Decommissioning and Dismantling of Nuclear Facilities
Status, Approaches, Challenges
ISBN 92-64-18488-0 – 2002
Free: paper or web.

Decommissioning Nuclear Power Plants
Policies, Strategies and Costs
ISBN 92-64-10431-3 – 2003
Price: € 40, US$ 46, £ 27, ¥ 5 100.



The Regulatory Challenges of Decommissioning Nuclear Reactors
ISBN 92-64-02120-5 – 2003
Free: paper or web.

Nuclear Decommissioning: A Proposed Standardised List of Items for Costing Purposes
Interim Technical Document
1999 – Free: only available on the web.

Decontamination Techniques Used in Decommissioning Activities
A Report by the NEA Task Group on Decontamination
1999 – Free: only available on the web.

OECD Nuclear Energy Agency
Le Seine Saint-Germain – 12, boulevard des Îles – F-92130 Issy-les-Moulineaux, France
Tel.: +33 (0)1 45 24 10 15 – Fax: +33 (0)1 45 24 11 10 – E-mail: nea@nea.fr – Internet: www.nea.fr

Cover photo: Heat exchanger lift-out at Windscale, United Kingdom.