Developments in radioactive waste management

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1. Introduction

On 10 March 1999, The Netherlands signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which was subsequently formally ratified on 26 April 2000 and entered into force on 18 June 2001. The Joint Convention obliges each contracting party to apply widely recognized principles and tools in order to achieve and maintain high standards of safety during management of spent fuel and radioactive waste. The Joint Convention also requires each party to report on the national implementation of these principles to review meetings of the parties to this Convention. At present 30 countries have ratified the Joint Convention. In November 2003 the first Review Meeting of the Joint Convention will be held in the headquarters of the International Atomic Energy Agency (IAEA) in Vienna.

On 30 January 2003 the European Commission adopted two draft Directives for consideration by the European Council:

1. A directive on the safety of nuclear installations during operation and decommissioning[1];
2. A directive on radioactive waste[2]

The main objective of the draft Directives is to ensure a common framework of safety standards within the countries of the European Union, particularly with a view to the envisaged enlargement of the Union on 1 January 2004.
More specific objectives include the following:

1. Establishment and maintenance of an equally high level of safety of nuclear installations in the countries of the Union.
2. Availability of adequate financial resources for the decommissioning funds of the nuclear facilities, with its own legal personality, distinct from that of the nuclear operator.

3. The requirement that Member States adopt, according to a pre-set timetable, national programmes for the storage of radioactive wastes in general and deep burial of highly radioactive wastes in particular. They are required to decide on (national or regional) burial sites for highly radioactive wastes at the latest by 2008 and to have the sites operational at the latest by 2018. For low-activity, short-life waste, storage arrangements must be ready at the latest by 2013.
4. By demonstrating the safe operation of nuclear power stations throughout the countries of the Union and by providing a solution for the radioactive waste generated by these facilities the position of nuclear energy amongst the other energy sources in the European Union should be secured as indicated in the EC's Green Paper.

2. The radioactive waste management approach in The Netherlands

2.1 Sources of waste

In the Netherlands radioactive waste originates from two nuclear power stations: a 450 MW_e PWR plant in Borssele (in operation) and a 55 MW_e BWR plant in Dodewaard (closed-down in 1997), by two research reactors (in Petten and Delft), the uranium enrichment facility in Almelo and about 200 users of radioactive materials and sources, including research institutions, hospitals and industries.

2.2 Categories and quantities of waste

Spent fuel and high level waste
Both nuclear power plants have entered into contracts for reprocessing of their spent fuel. The HLW resulting from reprocessing will be returned to the Netherlands. Since the Netherlands does not expect to have a capability to dispose of this HLW for the next few decades, an engineered HLW storage facility (named HABOG) is being established at the site of the Central Organisation for Radioactive Waste (COVRA). Spent fuel from the research reactors in Petten and Delft is also planned to be stored in HABOG.
The total amounts of HLW, spent nuclear fuel, etc. to be stored in HABOG are shown in Table 1:

Waste category	Volume (m^3)
Heat-generating waste	
- Fuel elements and fissile residues	40
- Vitrified HLW	70
Non heat-generating waste	
- Decommissioning waste	2000
- Reprocessing waste	810
- Other high activity waste	120

Table 1. Estimated total quantities of high level radioactive waste

It is envisaged that HLW is stored for at least 100 years in a dedicated engineered facility, the HABOG, which is now under construction at the COVRA site (see Figure 1). The HABOG is separated in two compartments, one for waste which requires cooling, e.g. the vitrified fission products and one for waste for which such requirement does not exist. The compartment for the storage of heat producing high level waste is of a vault type design, in which the waste canisters are placed in a closed system filled with an inert gas to prevent corrosion. The sealed enclosure for the canisters is designed to be cooled in its entirety by natural convection of air. The HABOG will also accommodate some or all of the spent fuel from the research reactors. The HABOG is scheduled to be taken into operation in the fall of 2003.

Low- and intermediate level waste

At present only low - and intermediate level radioactive waste (LILW) has been collected, processed, conditioned and stored. The management of all radioactive waste has been entrusted to the earlier mentioned specialized national agency, COVRA, founded in 1982 by the government and the electricity generating utilities. The facilities of COVRA in Borsele, which are in operation since 1992, include a waste processing and conditioning building comprising, amongst others, a 1500 tons super compactor for solid wastes, incinerators for animal carcasses and liquid organic wastes, a scrapping installation, a grouting installation, and a water treatment installation.

For the storage of LILW a separate prefabricated storage building was constructed. In December 1999 a total of about 25,000 waste packages (7000 m^3) of conditioned waste was held in storage. This amount increases annually with about 200 m^3 of conditioned waste.

Relatively large volumes of very low radioactive waste are produced in the ore-processing industry. Generally this waste is generated in the form of a relatively stable product, such as residues or slag, for which no further conditioning is needed; some 1000 m^3 is produced annually. The construction of a dedicated storage building for this type of waste was completed in the course of 2000.

2.3 Radioactive waste management policy

The foundation for the long-term radioactive waste management strategy in The Netherlands was laid in 1984 with the publication of a report by the Government to Parliament[3]. This strategy included the following:

- A centralized waste management organisation (COVRA);
- Long-term interim storage of radioactive waste;
- Eventually disposal in suitable rock formations in the deep underground;
- A national research programme to investigate the safety case of such a repository.

In 1994 the Government adopted a position paper on the feasibility and the acceptability of deep underground disposal of highly toxic and radioactive wastes[4]. This paper can be summarised as follows.

- In principle, the generation of highly toxic waste is undesirable from the point of view of sustainable development (integrated life-cycle management). The flow of highly toxic wastes should therefore be minimal, through the optimal use of prevention and recycling activities.
- Long-term disposal must be arranged for existing waste and for future waste if arising of this waste cannot be prevented. The disposal facility should be constructed in such a way that the waste is not only retrievable but that in principle the whole disposal process can be reversed. This requirement is imposed firstly with the aim to maintain control over the waste and secondly to ensure that the waste remains accessible for purposes of re-entering it into the cycle when such an opportunity arises provided that this can be done in an environmentally responsible manner.
- While recognising that salt formations in the deep underground provide a good natural isolation of the waste, a disposal method which excludes the possibility of retrieval is not in line with this policy and is therefore rejected.
- Further research focusing on retrievable disposal methods is to be carried out, preferably in an international framework.

3. Discussion of the national policy in relation to the European Directives

3.1 Radioactive waste management

The national approach as regards radioactive waste in the Netherlands is not quite in compliance with the timetable included in the draft European waste directive, since disposal is only envisaged in the far future.
However, there are good reasons to deviate from the preferred radioactive waste disposal scheme as contained in the draft EU directive.

- As shown in the Table the accumulated quantities of radioactive waste are not sufficient to justify the construction of an expensive repository in the deep underground at an early date.
- After a storage period of about 100 years most of the radionuclides which contribute significantly to the heat generation of the vitrified high level waste have decayed. The residual heat production is reduced to only a few percent of the original value. This will also reduce the heat load to the host rock material when the radioactive waste is eventually transferred to an underground repository.
- The capital investment required for the construction of an underground repository is relatively moderate, since by using cost discounting it is built up to the required level during the storage period.
- During the waiting period other, more advance waste management techniques may become available, which could obviate with the need for underground disposal.
- Finally, the waiting period can be utilized to involve a broad cross-section of stakeholders in the decision-making process for waste disposal, in order to increase the chances to obtain consensus on the method chosen.

3.2 Decommissioning of nuclear installations

In 1996 the electricity generating board decided to take the Dodewaard plant out of operation due to a lack of perspective for nuclear energy. As a follow-up of that decision a decommissioning plan was submitted to the regulatory body which envisaged bringing the plant in a condition of safe enclosure after removal of the fuel from the reactor. Actual dismantling of the remaining structures would commence after a cool-down period of about 40 years. The

envisaged end-point is restoration of the original situation (generally known as the “green field” option).
Since the government had a slight preference for direct dismantling two separate in-depth studies were commissioned to aid the decision-making process: one focusing on the radiation protection aspects, the other one addressing the financial aspects of the three decommissioning options considered.
The studies demonstrated that none of the options considered (direct, postponed and *in situ* dismantling) were found to be discriminating with respect to radiation protection and other safety aspects. However, the postponed dismantling option had clear financial advantages because of benefits of capital growth which increase with time.
In May 2000 the government decided that they would not oppose postponed dismantling.
It is expected that for the same reasons postponed decommissioning will be the preferred option for the Borssele nuclear power station. The required funds for the implementation of this option are available with the utilities.

4. Conclusions

A dedicated solution for The Netherlands is therefore to store the waste in buildings for a period of at least 100 years and to prepare financially, technically and socially the deep disposal during this period in such a way that it can really be implemented after the storage period. Of course at that time society has the freedom of choice between a continuation of the storage for another 100 years or to realise the final disposal.

5. References

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