STATUS OF THE RADIOACTIVE WASTE MANAGEMENT PROGRAM IN BELGIUM

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ABSTRACT

The R&D programme in Belgium has been focused on a number of specific topics, of particular importance for the situation in Belgium. (1) Volume reduction and conditioning of low level wastes from power stations, application of radioisotopes and fuel cycle operations. Processes have been developed and are operational for the high temperature slagging incineration and for the treatment of boric acid- and other concentrates from LWR coolant water. The latter treatment is based upon precipitation and separation of the bulk soluble salts from the radioactive constituants. (2) Characterization of conditioned low and high level wastes in view of their compatibility with the disposal environment (deep oceanwater, clay, surface sands, ...). (3) Geologic disposal of conditioned high level and alpha bearing wastes in deep clay layers. An underground laboratory has been constructed and is in operation now. The second phase of the program is being starded and aims at technological demonstration in situ using also conditioned radioactive wastes; it is foreseen to construct a disposal tunnel provided with disposal pits. This program is fully integrated in the program of the CEC and it benefits from exchanges and co-ordination with the member countries. For other areas in radioactive waste management, e.g. vitrification, one relies upon the technology which is commercially available elsewhere. Since 1981 the complete area of radioactive waste management is supervised and co-ordinated by the State Organization NIRAS/ONDRAF.

Since mid 1985, the installed nuclear power capacity in Belgium totals 5450 MW(e), all of the PWR-type. Consequently, in 1986, more than 60% of the generated electricity will be of nuclear origin.

In the field of nuclear fuel fabrication, two plants are in operation, one for low enriched UO_2 fuel (400 ton per year) and one for plutonium containing fuel (35 tons per year of MOx fuel for LWR's or 7 tons per year of FBR-fuel.)
At present, there is no reprocessing activity anymore in the former plant of Eurochemic, but decommissioning operations will be an other major source of radioactive wastes. It is also anticipated that the wastes from reprocessing at La Hague of spent fuel from Belgian power reactors are going to be returned to Belgium.

Other wastes are those resulting from research, from the application of radioisotopes and from past industrial operations in the field of uranium/radium processing and also current operations in the phosphate industry.

Organization of Radioactive Waste Management In Belgium.

The relative importance of the Belgian Nuclear programe thus gives a special emphasis on the radioactive waste management issue, taking into account that the country has limited opportunities for disposal. In this perspective the organization of radioactive waste management has been restructured since the promulgation, in 1980, of a law creating the Agency for the Management of Radioactive Waste and Fissile Materials (NIRAS/ONDRAF). The statutes of the Agency were defined by Royal Decree in May 1981. The Agency is entrusted with the definition and application of the waste management policy, in view of ensuring the current and long-term protection of the population and the environment.
The law also provides that all expenditures related to the activities developed or sponsored by the Agency, including the long term expenditures, are to be borne by the producers of radioactive wastes. The present activities of the Agency can be summarized as follows.

- The Agency has a service agreement with the SCK-CEN for the treatment aned conditioning of low-level wastes on behalf of the main producers. In particular, it ensures the quality control before and after treatment and the follow-up of all treatment and conditioning processes.
- The Agency ensures the interim storage of the conditioned wastes outside the sites of the waste producers; it also organizes or carries out the necessary studies in view of the final disposal.
- In the field of conditioning, the Agency has no facilities of its own, but it is entitled to acquire such installations or to take shares in such facilities.
- Together with SCK/CEN and the producers, the Agency decides or suggests on R & D activities and organizes the financial participation of the waste producers in such programmes.
- The Agency organizes the management scheme, making sure that the essential capabilities and capacities are available, also avoiding duplications of efforts or of installations.

MAIN OBJECTIVES IN RADIOACTIVE WASTE MANAGEMENT IN BELGIUM

Taking into account the prevailing conditions in Belgium (small country strongly dependent on nuclear energy), it became evident in the early 70's that, despite increased international collaboration in R&D, Belgium would have to find, on its own territory, a solution for the disposal of the conditioned high level and other actinide containing wastes. Since the interruption, in 1983, of the dumping of low level and short lived wastes in the Atlantic

Ocean, a terrestrial solution has also to be developed for the latter type of wastes. The following objectives - which had been adopted for the operations of the Mol facilities from the very beginning around 1956 have been confirmed:

- minimum direct release to the environment;
- maximum volume reduction;
- maximum leach resistance of the conditioned wastes;
- appropriate conditions for interim storage and disposal of the waste concentrates.

Releases to the Environment

Direct releases of radioactive effluents, liquid or gaseous, related to nuclear activities are subject to special licence. The quantities tolerated are based on ICRP recommendations and consider local conditions along the well-known ALARA principles. The permits are issued at national level through the intermediary of the municipal and provincial authorities.

Minimization of releases during intermediate storage and disposal is also one of the major objectives of the waste management. This point will be discussed here below.

Volume Reduction

In view of the safety and the economic feasibility of both intermediate storage and disposal of radioactive waste, volume reduction is considered to be a major objective of the waste management system and has led to the development of specific treatment and conditioning processes, such as :
- precipitation/filtration treatment of liquid effluents which, usually, leads to higher volume reduction than evaporation;
- incineration and high-temperature slagging of solid wastes;
- decontamination as a means of reducing the amounts of solid wastes.

Leach Resistance

For all types of wastes, the leach resistance of the conditioned concentrates has been and remains a major concern. On the technical level, this option has involved the development of some processes such as :
- bituminisation of ashes and treatment precipitates;

- high-temperature slagging of solid wastes, chemical sludges, ion exchange resins,...;
- application of vitrification for the conditioning of high-level wastes (PAMELA).

Interim Storage and Disposal.

For conditioned high-level and alpha bearing wastes, the geological disposal option has been selected for about 15 years. A broad R & D program is being conducted in this field as part of the program of the European Commission and NIRAS/ONDRAF. A deep clay formation located in the Mol area has been selected as host rock. More details are reported about the status of the disposal program further in this paper.

For low-level waste concentrates, sea dumping has been practiced until 1982 under the supervision of the Nuclear Energy Agency and according to the terms of the London Dumping Convention. These operations had to be discontinued mainly for political and public opinion reasons and it is difficult to foresee when they will be resumed.

Since 1983 the conditioned low level wastes are being accumulated in a temporary storage system and studies are underway for the selection of a site for shallow land burial, possibly making use of engineered barriers and other means for site improvement.

It can be noted that, up to now, continental disposal schemes for HLW, MLW and LLW do all have a domestic character.

MAIN ACTIVITIES IN THE FIELD OF WASTE MANAGEMENT IN BELGIUM

A general description of the technical aspects of the waste management program, including R & D and focusing on treatment, conditioning, storage and disposal is outlined in this section.

TECHNICAL DESCRIPTION OF TREATMENT AND CONDITIONING PROCESSES

Low-Level Waste

The facilities of SCK/CEN have gradually developed towards a "central" conditioning facility, not only for effluents and wastes produced on the nuclear site of Mol-Dessel (laboratories, fuel fabrication, reprocessing) but also for other nuclear facilities in the country,e.g. the power reactors and the users of radioisotopes. Transportation to Mol of non-treated wastes takes place in appropriate containers and under transport licences issued by the authorities of Public Health.

Volume reductions and conditioning at the Mol facilities are being achieved by precipitation/-flocculation, incineration, bitumisation, and high-temperature slagging incineration.

These operations give rise to about 700m^3 of conditioned concentrate per year composed of 10 % alpha suspect or contaminated material, 10 % coming from the application of radioisotopes; the remaining 80% result from compaction of non-combustible

wastes. This indicates the orientations of future development work in view of overall volume reduction.

Medium Level Waste

Until 1983, conditioned short lived MLW could be dumped in the sea. The major limiting factor was the surface dose rate of the packages and hence important volumes of concrete shielding were used in an irreversible manner.

Since 1983, volume reduction has become an essential objective and led to a revision of some treatment processes. Two examples are given below :
- Spent ion exchange resins are now being treated along the following scheme :

- regeneration of the resins followed by either reuse of the ion exchangers or incineration of the partly decontaminated resins by high-temperature slagging;
- chemical treatment of the regenerant solutions followed by bitumisation of the precipitate.

- Boric acid concentrates are also being treated by chemical precipitation and adsorption. The residual decontaminated salt solutions are being released and the precipitate conditioned by bituminisation.

High-Level Waste

The German company DWK has constructed its pilot vitrification plant (PAMELA) on the site of EUROCHEMIC, where it is being used for the conditioning of all HLW's accumulated on that site.

Alpha-bearing Waste

For highly contaminated wastes, wet oxidation has been experienced (ALONA) in view of the recovery of the contained plutonium. For low active alpha contaminated material, SCK/CEN operated the HTSI system at a capacity of about 50 kg per hour.

INTERIM STORAGE OF CONDITIONED WASTE

It is expected that, by 1990, the volume of conditioned wastes in Belgium will amount to 14,000 m^3. Up to now, conditioned low level wastes have been stored in warehouses at SCK/CEN and long-lived medium level wastes in the storage bunkers of EUROCHEMIC.

The Agency NIRAS/ONDRAF, taking into account that sea dumping has been discontinued, is preparing the construction of partly shielded temporary storage facilities prior to the transfer of the wastes to a licenced repository.

DISPOSAL OF CONDITIONED WASTE

Studies on geological disposal of high-level and alpha bearing wastes were started in 1974, when it became evident that HLW would have to be disposed of on the Belgian territory.

High-Level and Alpha Bearing Waste

In Belgium, the choice of geological formations suitable for disposal of very long live wastes is rather limited :
- there are no salt nor anhydrite formations known;
- granitic or other consolidated rock formations are known to be fractured;
- however, clay is abundant in shallow and deeper layers.

In particular, a thick and homogeneous clay layer, "Boom-clay", occurs beneath an area of nearly 5000 km2 in the North-East of the country. This clay presents a compact and homogeneous facies. At the nuclear site of Mol,it is found at a depth between 160 and 270m and is covered with glauconitic sand layers and aquifers. This clay is the subject of the study. The most important properties of the "Boom clay" layer are summarized here below. They lead to the conclusion that it is a potential suitable host rock for the disposal of conditioned high-level waste.

- The "Boom clay" formation at Mol offers a polyvalent and very efficient barrier against dispersion of radioactive material in the environment. High retention capacity of the clay for most of the radioelements, delay of migration due to an important cation exchange capacity and a very low water flow-rate in the clay contribute to the suitability of the clay layer as a barrier.

- The amount of FeS2 in the clay (2 to 5%) is such that, after sealing and backfilling, the effects of the exposure of clay to air (oxidation and acidification) during the exploitation of the repository will be corrected.

- The construction of the infrastructure of the repository in frozen is feasible although economically prohibitive. Although limited to the construction of a small shaft and drift, experience allows to expect drifting in non-frozen clay to be technically feasible. The demonstration of the latter at nominal scale has been decided

- Heat conductivity of clay is rather low (1.7W/(m.°C)) but problems of overheating can be overcome by appropriate design of the network of tunnels and disposal pits and application of an appropriate cooling scenario.

- Cost estimates made in co-operation with the CEC, lead to a value of about .3 mill ECU per kWh. Very similar figures were obtained for other geological formations.

- Safety and performance studies carried out up to now have to be understood as preliminary exercises. Main conclusions are that a radioactive waste repository in a clay formation, even at a depth of around 200 m, is able to provide an adequate isolation of the buried waste under circumstances of natural degradation of the system (geological site and conditioned waste). Also under conditions of disrupture (tectonic faulting and glacial erosion), uncertainty analyses led to very satisfactory results.

Performance studies in the context of the PAGIS action of the CEC and the redaction by NIRAS/ONDRAF and the SCK/CEN of a report (SAFIR) presenting and analysing the knowledge acquired in the past 12 years are being carried out. The objectives of this latter report are to allow the authorities to take position on the principle of the disposal of conditioned high-level and alpha bearing wastes into the clay formation underneath the Mol-Dessel site and for the scientists and technicians to identify critical items which require further investigation.

In complement of the studies performed up to now - which lead to the acceptability of the clay option - more field work has to be performed in order to demonstrate the technological feasibility.

Therefore, future development of the programme focuses on items which have still to be developed or demonstrated, e.g.:

- the possibility and/or technical problems in the digging of large diameter structures in non-

frozen clay;
- the impact of the system on stresses and overall mechanical behaviour of the structure;
- backfilling and sealing;
- costs for investment and operation;
- optimization of construction and operation of the repository and its components.

For this purpose the programme for the next ten years includes construction of a small demonstration facility and in situ tests with heat sources, radioactive samples and simulated and real wastes in conditioned and packaged form.

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