1-10 Spent Fuel Management and Storage in Germany

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In Germany the approach of spent fuel management changed completely during the last 40 years since the start-up of the first commercial reactor in 1966: Initially spent fuel management was based on the legal requirement of recycling uranium and using recovered plutonium. Consequently, the reprocessing of spent fuel was the only existing disposal route. With the amendment of the Atomic Energy Act in 1994 the option of a direct disposal of spent fuel into a final repository became legally equal to the reprocessing scenario. Due to the agreement between the government and the utilities in June 2000 the first scenario was abandoned, since from 1 June 2005 any delivery of spent fuel to reprocessing plants in France and UK was prohibited with the consequence that the direct disposal of unreprocessed spent fuel is the only available option in Germany today. The amount of vitrified high level waste (HLW) to be stored is defined because Germany is bound by a contract to take back all the HLW produced from the spent fuel which had been delivered before that date. In total, about 6,000 t HM will be returned. From France the return transports of 108 casks loaded with vitrified HLW containing steel-canisters have been nearly finished. In contrast to that the return transports of intermediate level waste (ILW) consisting of compacted hulls and endpieces and those of vitrified low level waste (LLW) have not been started yet. They are scheduled for 2015 and 2014, respectively. From UK ILW and LLW will be returned as a HLW-equivalent. About 21 casks with vitrified HLW are expected to be returned from 2014. The storage of the vitrified HLW is restricted to the centralized intermediate dry storage facility at Gorleben, whereas the future emplacement of compacted hulls and endpieces is destined for the centralized dry storage facility at Ahaus.

At present, 17 commercial power plants are in operation, 11 PWR and 6 BWR reactors, which produced about 135 TWh in 2009 and about 400 t HM per year on average. At the end of 2009 there were about 17,300 SFA corresponding to 5,700 tons HM which enter the direct disposal route. The agreement in 2000 also set the course for phasing out nuclear power by limiting the standard lifetime of the nuclear power plants to 32 years from the date of their commissioning. On this basis about 10,000 tons HM in total will accumulate for direct disposal. In case that the recent decision of the government to extend the reactor life time by 12 years on average will be realized the amount of spent fuel to be disposed of directly will have to be adjusted upwards.

The direct disposal of spent fuel into a deep final repository includes the following steps:

1. Intermediate storage of spent fuel
2. Conditioning of spent fuel
3. Direct disposal in deep geological formations

Intermediate storage of spent fuel

Following the agreement in 2000 12 decentralized new on-site interim dry storage facilities had been erected and licensed for the storage of spent fuel assemblies loaded in dual purpose casks for transport and storage as CASTOR® V-casks. Since the option for the direct disposal of HLW in a geological repository is not still available, the intermediate storage of SF is the only step in practice.

Conditioning of spent fuel

According to the German reference concept spent fuel assemblies are to be conditioned by separating fuel rods from the skeleton and loaded into self shielding casks designed for an emplacement in deep geological formations. The remaining structural parts will be compacted and thus space-sparingly disposed of. To prove the conditioning technology the pilot conditioning plant (PKA) was constructed for a capacity of 35 t HM per year and completely erected at Gorleben till 2000. At present, the operation of the PKA is restricted to the repair of casks loaded with spent fuel from nuclear power plants or high active waste returned from abroad. The approval process of the PKA has been finished but the pilot conditioning operation with spent fuel assemblies can only be started provided that the siting process for a repository has been completed, a definite repository site has been selected and the conditioning process has been qualified.

Direct disposal in deep geological formations

The German reference concept represents the first practical approach for the direct final disposal of spent fuel and vitrified high level active waste (HLW). The first concept was to load the separated spent fuel rods into a special cask for final disposal, the so called “POLLUX” cask designed for a disposal in drifts of a salt dome. The evidence of reliability for the handling technology was provided by emplacement tests using aboveground in full-scale test facilities. Two alternative concepts, both relying on bore hole emplacement, were considered in view of unification and flexibility of handling technology. Corresponding tests in full scale to demonstrate the functionality and reliability of the new emplacement technology in principal were successfully finished in 2009 for one of the two new concepts.

In conclusion, the disposal of spent fuel is technologically already solved to a large extent. The political decision on resuming the exploration of the salt dome in Gorleben and commissioning the first tentative safety analysis are important steps to move ahead on the way to a deep geological repository for heat-generating HLW.