Session 13
Panel: European Experience in Nuclear Power Plant Waste Management"

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Waste Management in Germany: A Summary of the Current Status

The following presentation summarizes the present back-end situation in Germany. The presentation is divided into three parts; the first and main part deals with the management of Spent Fuel, the second with the operational and decommissioning waste management and the third part describes the situation regarding the final repository in Germany.

Introduction

In Germany, 17 nuclear power plants (NPP) are currently in operation supplying 30 % of national electricity. Most of the units are large reactors of more than 1,000 MWe capacity. The youngest NPP (Neckarwestheim 2) was commissioned in 1989
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German reactors have achieved an excellent operating performance. The NPP Isar 2 is the current world leader in generating electricity. Other reactors like Grohnde, Brokdorf and Phillipsburg 2 ranked first in previous years.

In 2001, the anti-nuclear German Federal Government (Social Democrats / The Greens) and the German utilities signed an agreement to limit the residual lifetime of the existing nuclear power plants. However, undisturbed operation of the NPPs as well as the disposal of nuclear waste has to be ensured.

This agreement also stopped transportation of spent fuel for reprocessing after July 1st 2005 and requires interim storage facilities at reactor sites to store spent fuel. Until this time the German utilities used the reprocessing route for the spent fuel. They contracted huge reprocessing capacities at AREVA and Sellafield Ltd. (former BNFL).

In 2002, a law was passed in the German Parliament amending the German Atomic Energy Act phasing out nuclear power in Germany. According to this amendment a certain amount of electricity generation is allowed to each existing NPP. This electric energy corresponds with an operating time of about 32 years.

Picture 2 shows the currently published year of shutdown of nuclear power plants actually in operation in Germany that result from limited electricity generation. According to the Atomic Energy Act there is, however, an option to transfer a certain amount of electricity among the nuclear power plants, even though each individual case has to be approved by the German Government.

The "consensus agreement" between the former red/green government and the utilities (dated June 2001) remains still in force aiming for the "phase out" of nuclear power within the prescribed period (until approx. 2021) because no agreement could be reached between CDU/CSU and SPD with regard to the future use of nuclear energy in Germany. Nevertheless prominent members of Christian Democrats and the representatives of the big German electricity utilities stipulate an extension of the German NPPs operating periods beyond the agreed time frames laid down in the "consensus agreement".

In May 2007 the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has rejected an application of RWE submitted in September 2006 requesting approval for the transfer of electricity output from the remaining nuclear capacity from the decommissioned Molheim-Karlich to unit A of the Biblis NPP. This measure would enable the operation life of unit A to be extended approximately through the second half of 2011 from 2008. BMU argued that it is still reviewing RWE's application to transfer generation from its Emsland plant, which is still operating. RWE has started legal action against BMU's decision.

In December 2006 EnBW has submitted an application to BMU for the transfer of electricity output from unit 2 to unit 1 of Neckarwestheim NPP. Because BMU did not come to a decision within a reasonable time, EnBW has started legal action against BMU in March 2007. This measure would enable the service life of unit 1 to be extended through 2017. In August 2007, BMU has rejected an application of VENE submitted in March 2007 for the transfer of electricity output from the decommissioned Milheim-Karlich NPP to BrunsbOttel NPP. This measure would enable the service life of BrunsbUttel NPP to be extended through 2011 from 2009 now. A further application of VENE was submitted to BMU for the transfer of electricity output from KrUmmel NPP to BrunsbEittel NPP, for which BMU decision is still pending.

Management of Spent Fuel in Germany:

During the estimated lifetime of the nuclear power plants of 32 years of full power operation, a total of approx. 17,250 t of heavy metal in form of spent fuel assemblies will be generated. Up to the point when transports were stopped, approx. 6,150 t of this amount had been delivered to the reprocessing plants located in France and UK. For the remaining 11,100 t, interim storages capacities had to be provided until a final repository, to be erected by the Federal Government, will be available. Assuming a capacity of 10.5 t per cask, storage capacities of approx. 1,060 storage casks have to be provided in total at all twelve plants sites. The demand to build storage capacities at each NPP site results from the request not to carry out transports of spent fuel in Germany until a final repository will be available. In total, a storage capacity of 1,440 casks at 12 sites was realized in order to maintain flexibility for a transfer of electricity between nuclear power plants.

To comply with the described legal requirements, German utilities chose a dry cask storage concept. This technical concept had already been realized in two central cask storage facilities in Germany. Thus it could be implemented for on-site storage facilities in a shorter time with a more predictable expenditure in comparison to other storage concepts, such as wet storage or vault storage concepts. With only minor operational interfaces between storage facility and NPP at the site, the operation of the storage facility after shutdown of the NPP will be unproblematic.

Basically, two construction concepts were developed:

- o According to the first concept designed by STEAG encotec GmbH, the building was designed as a monolithic concrete structure. Heat removal is effected by natural convection via vents at the sidewalls and the opposing roof area. For this concept, the wall thicknesses and armoring ensure protection against penetration in case of an airplane crash
- o The other concept, designed by the company of consulting engineers WTI (Wissenschaftlich-Technische lngenieurberatung GmbH), includes a two-hall-construction made of cast-in-place concrete and pre-fabricated segments. Heat removal is effected by natural convection via vents at the sidewalls and in the centre of the roof area. Protection against external impact (airplane crash) is provided by the solid cask structure.
- o In addition, at one site, a two-tunnel-system in a quarry with an entry building for cross transports was erected. The tunnel walls are lined with reinforced concrete and the protection against external impact such as an airplane crash is provided by the solid rock structure above the tunnel. The cask heat will be removed via a vent stack.

Cask Types

For the time being, the fuel assemblies are stored in the casks type CASTOR®, designed and fabricated by the German manufacturer GNS mbH. In type CASTOR® V/19 for pressurized water reactors, up to 19 spent fuel assemblies can be stored; type CASTOR® V/52 for boiling water reactors takes up to 52 spent fuel assemblies. The CASTOW-casks are made of cast-iron with a borated steel basket.

To achieve diversity and flexibility, the development and licensing of different cask types as alternatives to the CASTOR casks were pursued. Those are the Type TN-fly' 24 E made by the French manufacturer AREVA TN International (TN I) for 21 PWR fuel assemblies, and the type MSF-57BG made by the Japanese manufacturer Mitsubishi Heavy Industries (MHI) for 57 BWR fuel assemblies. Instead of cast iron as used for the CASTOR type, these casks are made of forged steel with borated aluminum baskets.

First Operation Experience

At the beginning of 1996, the first CASTOR° V cask was loaded and stored in a central storage facility; the first on-site interim storage facility was taken into operation in 2002. In the loading processes, the casks are loaded, completely handled and checked inside the power plant. After the loading with spent fuel, the casks are drained and dried and finally equipped with the necessary pressure monitoring equipment and a protection plate.

Depending on site conditions, the casks are transported by rail or road vehicle to the on-site interim storage facility. After erection in the reception area, the casks can be transferred into a maintenance station in order to affect repair work of the coating, if necessary. After positioning in the storage area, a connection to the cask monitoring system is carried out. Monitoring the cask lid interspace between the primary and secondary lid ensures leak tightness of the casks during the whole storage period.

Between 1996 and September 30th 2007, in total 163 casks of CASTOR° V type have been loaded and stored in Germany. In the years to come, 50 to 60 casks will be loaded and stored each year.

Management Of Intermediate - And Low - Level Operational And Decommissioning Waste From The Nuclear Power Plants

The operation of NPP also produces low and intermediate level waste. This includes, for example, contaminated clothing, cleaning materials, tools, machine components, concentrated effluents, resins, filters and others. Since the beginning of the use of nuclear energy, this type of waste has been rising. Today a typical German NPP produces 30 to 40 m^3 of low and intermediate level waste per year.

Decommissioning of a NPP will create 5,000 to 6,000 m^3 of conditioned waste. This operational and decommissioning waste is normally stored at reactor-sites or in two storage facilities, which are available for all German utilities.
Only between 1992 and 1994, utilities used the former East-German final repository Morsleben to emplace 25,000 m^3 of low-level waste.
To date the German utilities have a stock of xxx m^3 of low and intermediate level waste. Larger quantities will arise within the next years from the dismantling projects of NPPs (e. g. KKS, Miiiheim-Kàrlich).

Although no final repository for this type of waste is available now (see the third part in this presentation), the German utilities face the problem that no final and binding conditions or terms for conditioning or treatment the waste and for the waste packages exist. That means that all conditioned waste packages are not final for an emplacement in a final repository.

Two even bigger problems have to be mentioned:

- o Waste packages
  To emplace waste package (e. g. containers, canisters, boxes) in a repository, the package has to have a package approval (license), proving the integrity of the package for special conditions like fire and drop.
  Only a few currently used packages have already such a package approval or license. For the majority of all packages, this package approval has yet to be applied for.
- o Documentation and declaration
  Each waste package has to have an extensive documentation file, in which a detailed description of the origin of the raw waste, the conditioning method and the content of non-radioactive but chemical-toxic matter has to be listed.
  Especially the procedure for the declaration of the chemical-toxic matter is not finalized. , The German utilities cannot finish the whole waste conditioning and treatment process for the waste as long as there is no final procedure for this.

To produce final waste packages ready for the emplacement, at least these two issues have to be solved.

The German Waste Disposal Concept

In Germany the issue of waste disposal was already under consideration when the use of nuclear energy was developed. Already in 1963, the Federal Government issued a recommendation to use rock salt formations for radioactive waste disposal. In 1973, planning for a national repository started, and in 1976, the Atomic Energy Act was amended to make such disposal a responsibility of the Federal Government.

In 1977, investigation of the salt dome in Gorleben started. A first site review in 1983 came to the conclusion that the rock formation is suitable to host high active waste. After this review the Federal Government decided to launch the subsurface investigation/exploration. This mining and the investigation war interrupted in 2000 as part of the "consensus agreement". It was agreed between the utilities and the government to stop further investigation in order to clarify doubts concerning concepts and safety of the Gorleben repository.

A final report of the Federal Agency for Radiation Protection (BfS) was published in November 2005. It was pointed out that in principle a final repository for heat generation waste is possible in all host rocks investigated. No principle matters put into question the suitability of the Gorleben site.

From the utilities' point of view, the exploration/investigation has to be resumed immediately. From a technical point of view, this final repository for HAW could become operational by 2030 - provided there will be no further constraints imposed by the German Government.

Konrad

In Germany a second final repository - the Konrad ore mine - has been under investigation since 1982.

The plan-approval (licensing) procedure initiated according to the law in 1982 was concluded in 2002 with the plan-approval decision delivered by the Lower Saxonian Environmental Ministry. This plan-approval application provides for the disposal of radioactive waste with negligible heat generation, which is about 90 % of the amount arising altogether in Germany.
German needs. This volume takes into account the residual operating lives of the NPP of max. 32 years stipulated in the consensus agreement of 2001.

According to the agreement between the Federal Government and the utilities of June 6, 200
The implacable waste package volume is limited to 303,000 m^3 exclusively for 1, BfS as applicant withdrew its application for immediate execution of the plan-approval decision in July 2000. Claims filed by communities and individuals thus had a "dilatory effect" for the execution of the license With its decision of March 8, 2006, the LOneburg Higher Administrative Court dismissed the claims and did not admit a revision at the Federal Administrative Court. All claimants filed complaints against the non-admittance of the revision. The complaints were dismissed by the Federal Administrative Court (BVerwG) on April 3, 2007. The legal remedies of administrative jurisdiction have thus been exhausted. A legal and unappealable plan-approval decision for the Konrad repository is now available.

In summer 2007 the BfS has established the "Construction of Konrad Repository" project group. This group coordinates the conversion of the Konrad mine into a repository. The actual conversion of the Konrad mine into a repository will take about four years. Thus, in total a period of about six years must be assumed until emplacement of radioactive waste can start in the Konrad mine; i. e. emplacement operation could start in 2013.