Transport of Heavy Load Radioactive Material in Germany

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1. High Active Waste

Nuclear generation has become over the last 4 decades a vital part of Germany's energetic fundament and is contributing to roughly one third of the overall electric generation (Figures of 2003: 31.7 %, i. e. 156.4 thou. GWh nuclear of 493.3 thou. GWh generated in total). And anyone who seriously tries to look beyond the outlet sockets on the wall when considering an economic reasonable energy supply which moreover is sustainable past the foreseeable exhaustion date of fossil fuels (which, in turn, will gain in value in the decades to come as raw material in chemistry) as well as environmental friendly without carbon dioxide emission, reliable and safe – must inevitably come to conclusions that oppose that "zeitgeist stand" and unsubstantiated "green dogma" to depart from all forms of nuclear generation.

Regardless what will be the options really taken in our future, the employment of fission reactor technology, despite all improvements made along its path to fruition and today's high achievements and standards, involved and will always involve one major problem: The emergence of high radioactive fission products. This fact is regrettable. It is uncomfortable. It makes a real problem. But it does not constitute that alleged "thumbs down" criterion with regard to the nuclear energy option, it simply can be managed.

Managing the problem of waste from nuclear power stations involves the transport of high active and thus still decay heat emanating fuel material to either reprocessing plants or storage facilities. And in this, NCS with its departments BES (for railroad shipments) and SLS (for heavy load shipments) has found its role.

2. Safe Containment of High Active Waste

Both spent fuel elements from nuclear generation sites and stainless steel cans containing vitrified residues from the reprocessing plants are highly radioactive matter and must be reliably contained and the environment shielded from any hazardous level of radiation, which most pertinently occurs in terms of gamma rays and neutrons. This necessitates the use of special flasks for transport and/or storage purposes, which must be tested and certified to meet the following generally and internationally accepted safety criteria:

- Securely exclude any critical assembly;
- Prevent any release of matter from the radioactive inventory under normal and accident conditions;
- Limit the radiation levels emitted from the radioactive substances;
- Remove the decay heat.

The following table gives examples for the main dimensions of flasks that are in use for the shipment of spent fuel and vitrified residues. The gross weights of up to and in excess of 100 tons can give an indication of the advantages of the railway system in hauling a cargo as bulky and heavy as that:

	Overall Length / mm	Max. Diameter / mm	Gross Weight / kg
TN 17/2	6.150,00	1.950,00	78.800,00
TN 13/2	6.670,00	2.500,00	113.500,00
NTL 11	6.126,00	2.200,00	94.000,00
Excellox 6	6.605,00	2.200,00	94.000,00
CASTOR S1	7.030,00	2.420,00	93.100,00
CASTOR V/19	6.822,00	3.070,00	139.200,00
CASTOR V/52	6.553,00	3.070,00	138.000,00
CASTOR 440/84	5.040,00	3.100,00	131.440,00
CASTOR HAW 20/28	7.015,00	2.500,00	116.200,00

Table 1: Main overall dimensions and gross weights of flasks for transport and storage of high active waste

Fig. 1: TN 13/2 flask from KKG Grafenrheinfeld is being transferred from road trailer onto railway wagon by means of a railway crane at Gochsheim train station.

3. Contamination Incident

3.1 Transports Halted

A significant discontinuance for the shipments of spent fuel for reprocessing arose in early 1998. It started with a report in a French paper on contamination values allegedly exceeding the limits of international regulations, measured on transport flasks and railcars from the French NPP Gravelines to the COGÉMA reprocessing plant at La Hague. The news of the incident spread, and, after a closer look, the French nuclear supervisory authority DSIN noticed their German counterpart BMU that a "significant number" of spent fuel shipments to the COGÉMA plant had revealed non-compliance with the established contamination limits. This was the onset of lots of media noise and turmoil and all happened in April 1998.

Whereas shipments within Great Britain and from the Netherlands, Switzerland, or Japan to the BNFL Sellafield plant at no point in time suffered from disruptions during the course of the affair, the German operators took on a "suggestion" from the BMU and "voluntarily" halted all shipments of spent fuel elements to COGÉMA and BNFL in May 1998.

The cause for the trouble was soon identified as "…inadequate observance of pertinent atomic law and dangerous goods ordinances and regulations." Given the strict anti-nuclear basic attitude of the new red-green government elected into power in the very year of 1998, it was now to become quite a lengthy process until eventually the transports from German NPP sites could be resumed.

The BMU issued a list of 10 criteria that was, after discussion, approved by the LAFAB ("Länderausschuß Kernenergie", states' commission on nuclear energy) in June 1999:

1) General Requirements (contamination limits to be observed, phase concept)
2) Technical Protective Measures (flask initial contamination before loading must be 1/10 of legal limit, basic decontamination and technical means to prevent surface contamination on flask handling required)
3) Radiation Monitoring (must be state-of-the-art, program to be reliable, comprehensive, and unambiguously documented)
4) Decontamination Processes (must be state-of-the-art and clean flasks without protraction of contamination)
5) In-Company Transport Management (coordination and surveillance must be assigned to a responsible person within each NPP)
6) Transport Organization and Responsibilities
7) Documentation
8) Transport Data Base
9) Duty of Information
10) Duty of Notification

A working group "Technik & Radiologie" (technology & radiology) had started its activities in parallel. The members came from all affected NPPs, NCS, and Acta Technologies to represent the reprocessors BNFL and COGÉMA. What was produced were a "Ablaufplan Kontaminationsschutz" (AP-K, sequence plan contamination protection) for each type of NPP (PWR-BWR) and the type of flask designated for use, the modus of shipment (road-rail), the applicable technical concept for preventing contamination (flask with cooling fins or rips), and also 3 variants of "Standard-Strahlenschutzanweisungen" (SSA, standard radiation protection procedures).

3.2 Transports Resumed

When the "Gutachten zur Beförderung abgebrannter Brennelemente in die Wiederaufarbeitungsanlagen" (experts' opinion report on transportation of spent fuel elements to reprocessing plants) was issued by GRS and ÖKO-Institut on November 22, 1999, another milestone on the way back to spent fuel disposal by reprocessing was reached. Subsequently the experts concluded all requirements and criteria delineated in the "Gutachten" were adequately addressed and covered by the package of measures aiming at precaution and supervision and remedial actions developed by the NPP operators so far.

The German-French agreement on "Wiederaufnahme von Nukleartransporten zwischen Deutschland und Frankreich" (agreement on resumption of shipments of nuclear material between Germany and France) was signed by chancellor Schröder and prime minister Jospin on January 31, 2001. And when on March 29, 2001, 6 CASTOR HAW 20/28 flasks had arrived at the TBL Gorleben, the resumption of nuclear transports had become a reality. On April 10, 2001, the first shipment of spent fuel from German nuclear stations to COGÉMA for reprocessing was facilitated (3 flasks from KKP Philippsburg, 1 flask from KKG Grafenrheinfeld, 1 flask from KWB Biblis). Shipments to BNFL had their new inception on April 24, 2001, with 3 flasks from GKN Neckarwestheim and 2 flasks leaving KWB Biblis.

3.3 Phase Concept

The new transport licenses were applied for and granted with provision of the phase concept. According to this, all actions for the shipment had to be done covered by procedures, documentation, sequence plans etc. devised subsequently for:

- Phase 1: Cold trials on NPP site only
- Phase 2: Shipments with amplified scope of measurement
- Phase 3: Routine transports

The above mentioned first transports of spent fuel for reprocessing were to be managed according to provisions for phase 2. This implies, each NPP would then have successfully completed cold trials (phase 1) with the empty flask to demonstrate its handling within the fuel pond would securely be facilitated without inflicting any kind of not strongly adherent contamination on its outer surface.

The provisions under phase 2 cover each individual step of the transport chain from shipment of the empty and clean flask to the NPP until the spent fuel is unloaded at the reprocessing plant with comprehensive programs of radiation monitoring and testing for contamination. Compliance with legal limits is verified and ensured by close supervision by authorities and their technical experts. All measured data are documented in the TDF ("transport documentation file") and in a "supporting documentation file", the latter reflecting the amplified scope for radiation monitoring as characteristic feature of phase 2.

The provisions of phase 2 have governed most transports of spent fuel to our reprocessors. Until September 2004 only KKS Stade has fulfilled all formal requirements to stride on and the shipments leaving KKS from that date on are "routine transports" under the provisions of phase 3.

4. Railroad Shipment of HAW

4.1 HAW Residues From Reprocessing

Since 2001, annually 12 CASTOR HAW 20/28 flasks with vitrified residues from the COGÉMA reprocessing plant at La Hague have been transported to the TBL Gorleben for interim storage, a total of 48 flasks. For the TBL Gorleben has no direct railway connection, the flasks come by railway only to the intermodal transfer station at Dannenberg Ost, some 30 km remote from Gorleben. Here the CASTORs are unloaded from the railway carriages and put on heavy-load road trailers, which then carry them over their last leg on their journey for interim storage.

Other than with the spent fuel flasks leaving Germany, the public attention and interest of the media in those transports are unabated on a high level. The event of the "Castor days" has meanwhile become an established ritual in the places around and between Gorleben and Dannenberg and shows many elements of a regional festival. Unfortunately this playground is entirely left to the antinuclear movement, and not all protesters adhere to legality when it comes to the choice of their means of protest. Militant blockades of the railroad track or the road section of the transport route are staged that lack both common sense and legality, and the very much regrettable outcome of such an unsuitable attempt was the tragic accident in November 2004 when a young Frenchman was deadly hit by the train.

Measures to counteract accidents like this and to warrant the secure shipment of the potentially dangerous HAW freight to its designated destination are costly and add considerably to the basic efforts required for the hauling and handling of the heavy load.

Fig. 2: Two flasks TN 12/2 are ready to leave the KMK Mülheim-Kärlich power station

Fig. 3: The train with 12 HAW-flasks has arrived at Seelze train station

With regard to railway operation, these trains carrying 12 CASTOR flasks will always be special trains which require a sound preparation and a great deal of skill and care because of their heavy-weight load. Planning and scheduling of these shipments as well as the execution are done in close cooperation with the pertinent specialists of the German railway company and with security authorities both on federal and state level.

4.2 Spent Fuel For Reprocessing

In the years before the 1998 contamination affair, individual railway wagons carried the spent fuel flasks bound for COGÉMA and BNFL for reprocessing that were run in normal scheduled freight trains. The public took no interest at all in these transports and procedures.

This situation has changed considerably with the year 2001, when shipments were resumed. The contamination incident with findings, accusations, statements, reports, and eventually agreements on high level had been widely covered by the media, which in turn had spurred intensive public interest. Moreover, "phasing out" of nuclear generation had become the perspective for the German energetic future, officially agreed upon in the 2000 contract between red-green government and utilities. And the antinuclear protest movement took on the paths of spent fuel disposal as a "vulnerable spot" of the nuclear power stations in their attempts to enforce their immediate decommissioning, even before the negotiated period for operation has ended.

As a consequence, the transports were completely reorganized. The new concept of the transports can be characterized by:

- Special (dedicated) trains;
- Considerable efforts to secure the shipment by police forces, both escorts on the train as well as local units along the railway track;
- Flasks from several NPP sites are planned to unite at suitable conjunction points (marshalling yards) into one transport. Thus the final train resembles a river, brought forth by its tributaries on its way to the sea.

As an example, the "record" train of October 10, 2002, consisted of 16 flasks and totalled 2700 tons when it finally was to pass the border to France near Saarbrücken (cf. poster on following page).

Fig. 4: Dedicated train hauling 7 flasks with spent fuel elements passing station Koblenz-Lützel

5. Prospect on Future

With June 2005 the shipments of spent fuel for reprocessing or into centralized interim storage will be disrupted. This time for maybe 30 or 40 years, the period, for which the temporary storage facilities on each NPP site are designed and licensed. After these decades, presumably, our children and grandchildren will have to resume the task and transport the spent fuel elements – to either their final storage facility, or, which seems more likely, to a reprocessing plant to utilize the remaining content of fissile material in new reactors for energy production to satisfy the ever increasing energy demand of a society that has unanimously come to a more realistic and pragmatical outlook on the global energy situation.