Return of Reprocessing Waste From France to Germany: Assessment of Radiological Impact for Incident-Free Transport

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OBJECTIVES OF THE STUDY

A transport risk assessment study has been completed on behalf of the French Nuclear Protection and Safety Institute (IPSN), France, the Federal Ministry of Environment, Nature Protection and Reactor Safety (BMU), Germany, and the Directorate-General for Environment, Nuclear Safety and Civil Protection, (XI-A-I) of the European Commission (EC) with the objective to provide an overview of the type, quantity, and characteristics of radioactive waste resulting from reprocessing of German spent nuclear fuel at Cogema La Hague Reprocessing Plant and to estimate the order of magnitude of the radiological risks arising from the transport of this radioactive waste by road and rail from France to Germany.

The radiological risks entailed in the transport and handling operations of the reprocessing waste materials considered in the study include both the radiation exposure related to the routine transportation (accident-free) and the probabilistic assessment for potential accidental exposure. This paper is related to the assessment of the radiological risk arising from routine transportation, while the accidental exposure is described in a companion paper presented at this meeting (Schwarz et al. 1995).

TYPE AND QUANTITY OF WASTE RETURN SHIPMENTS

Overall, four kinds of radioactive waste arising from reprocessing of German spent nuclear fuel at the La Hague Reprocessing Plant have been identified and will be returned to the country of origin at due time: vitrified high-level radioactive waste, hulls and end caps, bituminous waste (sludge etc.), and intermediate-level and low-level solid technological waste. This transport risk assessment study, however, concerns transportation of waste, over a time period of about 10 years from now, which has been generated from reprocessing of 4650 tons (HM) of spent nuclear fuel within the first 10-year reprocessing contract (1985-

1995) between Cogema and its German customers (utilities). Based on current planning, the types of waste expected to be returned from France within the study period, i.e., from approximately 1995 - 2003/04, for interim storage at the Gorleben Facility include only:

- Vitrified high-level radioactive waste
- Intermediate-level bituminous waste

The other radioactive waste streams, i.e., hulls/end caps and technological waste, are according to currently available information considered to be suitable for supercompaction, to reduce the volume, and will most likely not be returned within the 10-year time period covered by this study. Similarly, the risks of transporting spent nuclear fuel from Germany to France and shipments of uranium and plutonium recovered from the spent fuel will not be covered by the study.

The vitrified high-level radioactive waste (HAW) contains the bulk of fission products and transuranic elements - except uranium and plutonium - of the spent nuclear fuel immobilized in a solid glass matrix and encapsulated in a 175-l stainless steel canister. The canister radioactivity inventory is about 30 000 TBq (nominal), primarily beta/gamma-emitting radionuclides. The canisters will be shipped in accordance with the relevant Transport Regulations either in heavy CASTOR HAW 20/28 or TS 28 V casks. About 2800 canisters are forecast to be returned from France to Germany leading to an average of 15 shipments per year within a time period of about 8 years. The conservatively estimated average 1-m dose rate of the casks is approximately 0.11 mSv/h for the CASTOR HAW 20/28 and slightly lower for the TS 28 V.

The low- and intermediate-level radioactive liquid plant effluents are purified by coprecipitation or evaporation and the resulting sludge is immobilized in a bituminous matrix and poured into a 225 l stainless steel drum. Lower radionuclide inventories are found in bituminous waste materials with a nominal total activity of about 2.2 TBq per drum (99% beta/gamma-emitting radionuclides). The steel drums will be transported in a cubical cast-iron 'Container VII' having a capacity of five drums. A total volume of 3600 drums has conservatively been assumed to be returned from France in the study period (in practice, due to progress in the plant process design, this volume could be limited to the 1200 drums already produced). This conforms to an average of 50 railcars per year (assuming a shipping period of 7 years (1997 -2003) and a loading capacity of two transport containers per wagon). The container dose rate has conservatively been assumed to be on the order of 0.2 mSv/h at 1m from the container surface.

Type of Waste	Vitrified Waste (HAW)	Bituminous Waste (ILW)
Primary Waste Package Type outer dimension (m)	Canister 175-l Ø 0.43 x 1.34, 5 mm thickness	225-l drum Ø 0.586 x 0.883, 20 kg (empty)
Transport Container Type (m)	Castor HAW 20/28 Ø 2.5 x 5.9, 112 tons TS 28 V Ø 2.4 x 6.6, 112 tons	Cast iron 'Container VII' 1.6 x 2 x 1.45, 20 tons
Total Number of Packages	2800	3600
Total Number of Transport Containers	120 20 or 28 canisters per container	720 5 drums per container
Total Number of Railway Wagons	120 1 Castor HAW or TS 28 V per wagon	360 2 'Containers VII' per wagon
1 m-Dose Rate of the Transport Container (mSv/h)	0.11	0.2

WASTE TRANSPORTATION

The first part of the report concerns the radiological consequences from routine (incident-free) transportation with the following results:

As the detailed schedule for the shipment is not yet fixed, it has been assumed that during the period from 1995 - 2003/04 an average of about 115 waste transport casks or containers will be conveyed per year from France to Germany. This corresponds to an annual number of about 65 railway wagons to be shipped.

At that time, the preferred mode of transport for all waste materials is by rail. Road transportation will be limited to a small fraction of the journey between the La Hague Reprocessing Plant and the Valognes loading terminal (road-rail transfer) and similarly between the Dannenberg loading terminal (railroad transfer) and the Interim Storage Facility Gorleben. It is generally assumed that each consignment is limited to a maximum of three waste wagons per train (non-dedicated trains, mixed cargo trains), with an average of two railcars. The journey covers a distance of about 1400 km (almost equally distributed in length between France and Germany) along a route with an average population density of about 358 persons/km^2.

RADIATION EXPOSURE FROM ROUTINE WASTE TRANSPORTATION

The computer code INTERTRAN II (IAEA reference code) has been used to determine the collective dose to the population and transport personnel (Neuhauser et al. 1993). The following results are obtained:

Type of Waste	Crew man-Sv/yr.	Public man-Sv/yr.	Total man-Sv/yr.	%
Vitrified Waste	2.04E-03	4.85E-03	**6.89E-03**	16.7 %
Bituminous Waste	1.44E-02	2.01E-02	**3.45E-02**	83.3 %
Total	**1.64E-02**	**2.50E-02**	**4.14E-02**	100.0 %
%	39.6 %	60.4 %	100.0 %	

For the public, radiological impacts are estimated along the shipping route (performing the dose calculation over a distance of 800 m on each side), and during stop time in the marshaling yard. Occupational exposures concern the drivers of the train (crew) and the personnel of the loading terminals of Valognes and Dannenberg. For this last category a total collective dose of 0.01 man-Sv/yr. at each loading terminal has been estimated for handlers, crane operators and the health physicist.

According to the asumptions adopted in this study, the predicted individual doses to members of the public and the transport personnel (critical group individuals) from routine transportation are on the order of:

- < 0.01 mSv/yr for residents/by-passers living close to the transport path and 0.02 mSv/yr for workers of a scrap metal yard located close to the siding tracks of the Ehrang railyard;
- < 0.03 mSv/yr for permanent residents (i.e. critical group) at the Valognes loading terminal and at the loading terminal of Dannenberg;
- 0.03 - 0.2 mSv/yr for railway personnel, i.e. train driver, shunters, escorts, and inspectors;
- 0.7 - 1.7 mSv/yr for handlers, crane operator, and the health physicist of the Dannenberg and Valognes loading terminals.

CONCLUSION

The study shows that the collective dose estimates attributable to the transportation of reprocessing waste material are clearly below the values predicted in previous studies for waste transports to the Centre de l'Aube disposal facility (0.48 man-Sv/yr) (Tort et al. 1992), (Raffestin et al. 1994), France, or the designated Konrad Repository (0.3 man-Sv/yr) in Germany (Lange et al. 1992).

The conservatively predicted individual doses (critical group) to members of the public represent only a small fraction of the applicable dose limits of the IAEA Transport Regulations or the dose limits recommended by the International Commission on Radiological Protection (ICRP-Publ. 60). Moreover, the doses to the public are much smaller than the range of variation of the natural radiation exposure in the Member States of the European Union. For personnel involved in the transport operations, the predicted individual doses to the critical groups of workers are well within the applicable dose limits of the IAEA Transport Regulations as well as the limits of the International Commission on Radiological Protection (ICRP, 1990) for occupational exposure.

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