WASTE TRANSPORT REQUIREMENTS TO THE FUTURE GEOLOGICAL REPOSITORY

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1 ABSTRACT

In France, the deep geological repository operations are scheduled to start in 2025, provided that it is authorized after the evaluation in 2015 of the license application and the future Act on reversibility requirements for the disposal. The feasibility of waste transportation from production sites to the repository has to be examined. The repository will handle both HLW and ILW-LL waste. Some of these wastes have already been transported to their "home" country after reprocessing (CSD-V glass canisters, CSD-C compacted hulls and ends, etc.). However, for a large number of these wastes, no transport outside of the facility boundaries has yet been fulfilled.

This paper will recall the 2009 waste inventory of the repository and identify the needs for new transport packages, and the associated transport means. The transport flow to the repository is assumed to last about 100 years, therefore it is necessary to define the local integration of the transports to the future disposal. This will be a key point for the public debate in 2013. On this basis, this paper will also give an overview of the transport logistics, and on the associated infrastructures.

The local transport logistics (rail and/or road) and associated infrastructures shall take into account the siting of the repository and the results of the dialogue with local stakeholders. A sustainable development approach should lead to favor as much as possible railroad transport for the whole journey from the producers'sites. The transport package designs (under the responsibility of waste producers) have to be anticipated because they are an input data for repository design. Type B packages are compulsory for HLW waste and for a large part of ILW-LL waste. However, on-going studies show that some ILW-LL waste have a low specific activity (A2/g) and could be transported in industrial package. The inventory includes a large variety of waste that have been produced and conditionned long ago.

As usual, transport is a key factor in nuclear operations. Anticipation of the needs is compulsory in order to avoid difficulties in the future and provide the community with a reliable solution for waste transfer when the repository will be authorized.

2 Introduction

In France, the 2006 Programme Act (N°2006-739 June 28th) on the Sustainable Management of Radioactive Materials and Wastes has set a goal for commissioning the deep geological repository in 2025, should its authorization be granted. The law defines the licensing process: Andra will prepare an information report as input for the public debate to be held in 2013; following this debate, Andra will file a license application concerning the waste repository to be reviewed by relevant authorities in 2015; local communities will be consulted on the application ; a new law will define reversibility conditions for the repository ; the licence to create the repository shall then be granted by the Government after public inquiry.

This objective requires reviewing the integration of waste transport in the facility design and in the repository siting process. This analysis may underline development needs for certain transport means such as casks and road or railway infrastructure. Waste producers are responsible for waste transport from their production site to the repository site and for the development of new equipment (casks…). However, Andra needs to anticipate these future developments in order to evaluate the transport flows, the capacity of the existing local transport infrastructure and to design the surface facilities of the repository.

The French repository will host vitrified high level wastes (HLW) and intermediate level long-lived wastes (ILW-LL) of French origin; waste issued from foreign spent fuel recycling by Areva is shipped back to their country of origin according to the French law. The transport of the waste packages will be achievable provided that:

i. Transport solutions are available for each category of waste to be disposed of.

ii. Suitable infrastructure is in place to transport the waste from the production site to the future repository site.

This second point comprises an analysis of the main infrastructure on the production sites and of the existing infrastructure within the Meuse/Haute-Marne site. At the present stage, the modalities for “national” transports (between the production sites and the Meuse/Haute-Marne site) are assumed not to present specific technical issues, since similar transports are already operated by the nuclear industry throughout France. Since most of the transports to the repository require Type B packages for transports and may require heavy loads transport, railway transport seems an appropriate solution for most of these national transports. This solution is also coherent with the environmental will to develop freight railway transport.

The ongoing stepwise siting process of the future deep geological repository has in 2010 narrowed to a 30 km² underground zone “ZIRA” in the Meuse/Haute Marne URL. Local stakeholders are strongly involved in this process that also addresses locating the surface facilities nearby. The repository design provides flexibility for the respective locations of surface and underground facilities. The analysis of the flows and of the existing infrastructure is necessary in order to minimize the impact of waste packages transport and to propose adequate solutions.

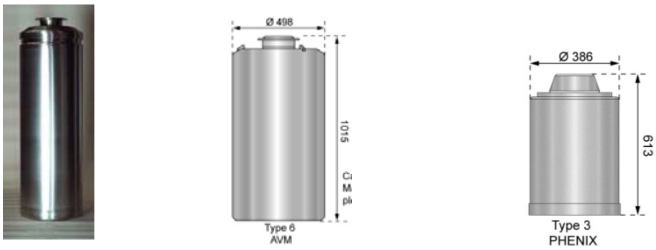
3 DISPOSAL INVENTORY AND TRANSPORT CLASSIFICATION

Transport rules are defined by the content of the waste to be transported. The repository will host both ILW-LL and HLW wastes. HLW packages require a Type B transport cask. Due to the variety of ILW-LL, an analysis will have to be done in order to define the adequate transport casks (Type B or IP2) for each category of these wastes.

3.1 HLW packages

HLW packages are conditioned in three types of canisters (see Figure 1). Most of the inventory is located on the AREVA reprocessing facility at La Hague (R7 –T7). The waste is conditioned in a standard “CSD-V” canister. The residual heat of a CSD-V has to decrease below 500 W before disposal (no transport foreseen before 2050).

The other HLW canisters are located on the CEA site at Marcoule (3 320 canisters). They were generated by the first vitrification facilities such as PIVER and AVM. They have a moderate thermal output (average 155W in 2025) that is compatible with a disposal at the opening of the repository. For these canisters, the adequate transport equipments have still to be defined.



CSD-V AVM canister PIVER canister

Figure 1: The three types of HLW canisters

3.2 <u>ILW-LL packages</u>

The ILW-LL canisters vary in waste content, geometry, mass, and packaging. The wastes are conditioned either in metal envelopes or directly in concrete shells, most of the time in cylindrical shape packages. The mass of these primary packages varies from 300 kg to a maximum of 7 metric tons, the diameters from 0.4 m to 1.8 m, and the height from 0.7 m to 1.7 m. They can basically be split into three major categories:

- Bitumen sludge generated by the traditional treatment of liquid wastes (see Figure 2) ;
- Technological wastes (see Figure 2) ;
- Structural wastes (fuel hulls and endpieces in CSD-C, activated reactor core structures).

20 to 30% of the 2009 inventory of the ILW-LL inventory is constituted of bitumen packages ; 15 to 20% of compacted hulls and endpieces ; the remaining covers mainly technological wastes, with a large part of very old waste in small amounts with specific conditioning.

On the basis of the radionuclide content of the waste, preliminary studies show that most of ILW-LL packages should be transported under Type B package transport agreement. However, a detailed analysis of some sub-families shows that they belong to LSA material and that their average specific activity remains below the A2/g limit (10-4 for LSA II solid) and hence that they could be transported in IP2 packages, provided that they meet all the other associated requirements.

Andra has identified two categories of waste which producers could classify as IP2 :

- Part of the 220 l bitumen waste, but only in small amounts (no more than 4 drums/ISO).
- Some cemented filtration sludge

Bitumen sludge packages (220l and 380l) Concrete waste packages (CBFC'2 & CEA 500 l) Waste package in a metallic envelope (CEA 1000l and 870l)

Figure 2: Illustration of technological waste

4 NEED FOR TRANSPORT CASKS

4.1 HLW transport cask: existing solutions and development needs

Due to their fission products content, all HLW packages exceed the 10^{-4} A2/g specific activity limit and the A2 total activity limit. Their transport needs Type B casks. At least two French transport casks are licensed and currently in operation: TN28 and TN81 (see Figure 3). They have a capacity of 28 standard canisters (CSD-V). These casks are large and heavy (113 metric tons); they require specific trucks and trailers for road transport from the La Hague facility to the Valognes rail terminal. Some transports were organized in large convoys (up to 13 wagons) from Valognes to Gorleben.

For the HLW packages stored in the CEA Marcoule facility (PIVER and AVM vitrified waste), transport solutions need to be developed prior to disposal. This means developing or adapting existing casks such as TN28 to this new content. Storage facilities also have to be adapted in order to be able to load these waste packages in the transport cask. This example shows that an integrated transport strategy has to be developed in order to transfer the canisters from the production site to the repository site.

Figure 3 : TN 81 (Source AREVA)

4.2 ILW-LL transport casks: existing solutions and development needs

In the inventory, only a few ILW-LL waste have already requested a transport feasibility study (hulls & end pieces in CSDC, 220l bitumen drums, and CBFC'2). The main reason is that those waste are stored in the producer's facilities and that the only transport to come is either a transport to the foreign owner of the wastes, either a transport to the deep geological repository. Hulls and endpieces in CSD-C have already been transported by AREVA; a new TNI Type B cask for bitumen (220 l drums) transport is under review for licensing (waste return to Spain). These solutions will be available for the transport of these wastes to the repository.

For the CSD-C, various cask designs are envisaged by AREVA. The maximum capacity would be of 36 canisters in a 120 metric ton cask (with two possible designs, one being compatible with interim storage). Alternative casks with a lower capacity of 20 or 24 canisters provide lower weights, and compatibility with specific storage facilities.

For 220 l drums, AREVA's cask design enable the transport of 2x6 drums with a total weight of around 45 metric tons. The cask dimensions would be a cylinder with a 2.5 m diameter and a 2.5 m height. The cask could be loaded and transported in an upright position.

For wastes conditioned in CBFC'2, a similar cask design is developed, with a capacity of 3 CBFC'2 concrete canisters. For the other ILW-LL wastes, specific studies have still to be launched.

4.3 Cask development design options (Type B, IP2) and schedule

In order to define solutions for waste transport to the repository, two options may be considered: (i) design of a dedicated cask for each waste, or (ii) design of a multipurpose cask for packages that are quite similar in dimensions and weight. A Type B multipurpose cask would enable using the same outer shell and could reduce the development cost, which includes the agreement delivery. However, a multipurpose cask would require changing the internals in order to fit to each specific waste. For waste under IP2 regulation, adaptation of an ISO 20ft container seems the best approach.

In both options, the design choice for Type B cask capacity is related to its performance in mass, size and in the number of transports. The basic approach consists in maximizing the capacity of the cask, in order to minimize the number of transports, by designing the cask at the maximum weight compatible with transport constraints (around 110 metric tons). This approach would minimize the local flows in the neighborhood of the production facilities and of the repository. An alternative approach is necessary when the facilities or infrastructure introduce a limiting factor on the size or weight of the cask. A smaller capacity induces a greater number of transports. In order to obtain a similar flowrate compared to the previous approach, the fleet size has to be increased, which has an impact on the design of the surface installations of the repository.

The delivery of a Type B agreement is usually a long process. Once the cask model is agreed, there is also a lapse of time for the construction of the fleet of casks and its commissioning. Studies for new transport casks should therefore be launched in accordance with the operating schedule of the repository and the waste delivery scenarios. The definition of the transport fleet will be complex, because it will involve the canister itself, the schedule of its transport, and the optimization of costs.

Basically two extreme orientations may be considered to deliver the packages for one disposal cell in operation :

(i) balance the transport schedule with disposal operations; this approach needs a certain fleet of casks for the considered waste, but minimizes the capacity of interim storage on the repository site ;

(ii) optimize the number of casks, using greater interim storage capacities on the repository site.

5 CONVEYANCE SYSTEMS

Cask dimensions and weight can be adapted to the infrastructure and to the shipping and receiving facilities. Developing railway transport solutions for waste flows seems an interesting option, for many reasons including the limited number of sites, minimization of the number of yearly convoys and environmental aspects (CO2 reduction).

Specific wagons have been developed for spent fuel and HLW canisters. For a 112 metric ton cask, a 25 m long wagon will be used. In case of a smaller cask around 40 metric tons, shorter wagons could be used. A shorter and lighter wagon could go on some secondary freight lines, which may not be accessible to long and heavy wagons without infrastructure improvements.

Since not every facility is directly connected to the railway network, it is also necessary to consider local road transport requirements. For the heaviest Type B transport packages, such as spent fuel and HLW, specific trucks and trailers are used. For a 112 ton cask, a 20 m long trailer towed by a powerful truck will be needed. The total length of the convoy is around 26 m.

6 MAIN TRANSPORT ROUTES – FLOWS

6.1 Main transport routes to the repository

Waste is located in three main places: La Hague near Cherbourg, Marcoule and Cadarache in the Rhone Valley (see Figure 4). HLW canisters are located in La Hague and Marcoule. ILW-LL wastes are mainly located in La Hague, Marcoule, Cadarache and Bugey (in the future). Two main routes to the repository will have to be defined: one route from La Hague, and one route from the Rhone Valley.

La Hague operates a number of Type B transports for spent fuel and HLW (over 200 by year). All spent fuel and continental HLW transports are shipped by train. It seems reasonable to adopt a similar approach to ship French HLW and ILW-LL to the repository site. At the moment, Marcoule and Cadarache do operate much fewer Type B transports.

The shipments of low level waste to the surface repository (Aube) are mainly done by road although a railway terminal is located near the Aube facility. Andra is studying how develop the use of railway facilities.

Taking into account the annual flowrates for ILW-LL, the characteristics of the Type B transport flows and the distance to the repository, a rail transport shall be considered. Road transport could be required for transport to the local rail terminals. Depending on the compatibility of existing roads with heavy transports (100 to 120 metric ton casks), it may be necessary to limit the maximum weight of the casks or to examine infrastructure improvements.

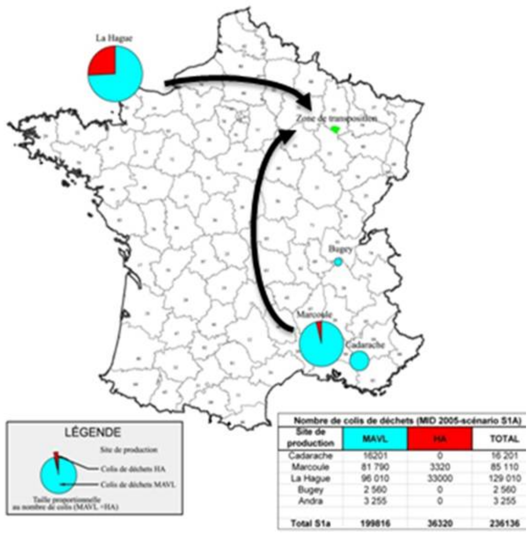


Figure 4 Main routes to the future repository

Regarding the future repository, a direct rail terminal would be the preferred solution, to reduce the number of road transports out of the site. However, if a direct connection was not possible, a final short distance transport by road could also be considered.

6.2 Estimating the waste flows to the repository

For HLW, the 2009 assumption is that CEA Marcoule's waste package with a moderate thermal output would be delivered early to the repository on an 11 year period. This corresponds to the shipment of 300 HLW packages per year and may be achieved with 11 transports in a TN28 or TN81 cask. Even with a lower capacity cask, the number of transports would remain low (an average of 1 or 2 casks per month). For the higher thermal output HLW, the average annual flowrate shall raise to 500 units per year (for 80 years). The number of transports in TN28 or TN81 would be a little less than 2 casks per month.

For ILW-LL, the 2009 assumption of 80 years of operation, lead to assume an average of 300/350 transports/year (half of the 2005 simplified approach with 40 years of operation). A first 2009 operating scenario has been based on campaigns by type of waste. Notwithstanding the validity of cask capacity, the yearly figure of transport will vary, depending on the waste canister volume and mass, from 200 to 500 transports/year. Rail transport makes it possible to ship up to 10 casks per convoy. In such a case, the maximum waste flow would lead to approximately 1 train per week. Cask investment optimization may lead to alternate solutions, with more rail shipments.

7 REPOSITORY INFRASTRUCTURE OPTIONS

As explained hereafter, two options may be considered for nuclear transport in the future: new rail infrastructure to the repository site, or an approach similar to La Hague, with a final trip by road from a rail terminal to the surface nuclear facilities of the repository.

A general view of the Meuse/Haute Marne area (see Figure 6 & Figure 7) presents the main transport axes. The western axis in the Marne Valley provides railway and road infrastructure. The eastern axis in the Ornain Valley provides similar infrastructure with a smaller capacity. In the south there is also a road connexion (RD60/960), already used for the Bure Laboratory. Although two waterways exist in the vicinity of the site, a preliminary analysis shows that this transport mode should be discarded for nuclear transport.

7.1 A benchmark: La Hague

The La Hague facility area illustrates different options to be considered at the repository site. La Hague has the ability to ship by road, by train and even by sea (the Cherbourg harbor). La Hague provides an example of a rail terminal not located directly on the nuclear site, with regular transports of Type B casks on country side roads.

The Valognes rail terminal (see Figure 5) is the largest rail terminal for Type B transport packages in France. It handles over 200 Type B casks each year and many other packages (uranyle nitrate tanks for instance). It has been equipped with covered facilities where the non-contamination tests are conducted: on the cask itself and on the wagon. It is operated with long trains (around 10 wagons) dedicated to nuclear material/waste transport. Every week, one loaded train is unloaded on trailers that carry the casks to La Hague. Empty casks are loaded on a train back to the utilities (for spent fuel).

Figure 5 Valognes rail terminal (source : AREVA)

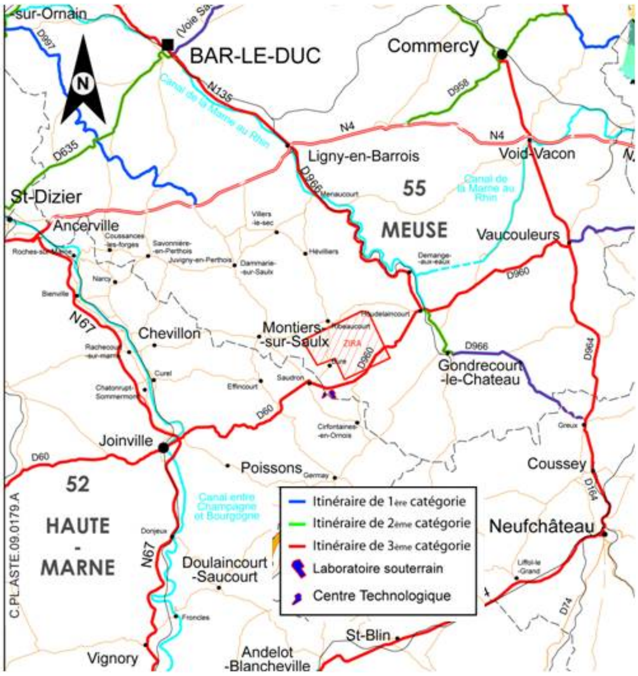
7.2 Road infrastructure

The repository siting area is in the vicinity of main roads. An analysis of the possible existing routes for exceptional transports has been carried out (see Figure 6). Red and orange (motorway) may be used for exceptional transports.

The access to the repository site requires a specific and detailed study of the roads within the area with the local stakeholders, specially the road operators. Aspects to be checked include: urban crossings constraints, bridges weight and template limits, road curves, availability, local uses, etc. This analysis will determine the infrastructure work to plan in relationship with the siting of the surface facilities of the repository. Possible scenarios for surface implantation are being discussed in collaboration with local stakeholders. These scenarios are necessary for the subsequent studies that will examine more precisely the possible routes adapted to each scenario and the necessary improvements on the infrastructure.

7.3 Railway infrastructure

The main railways are electrified (shown in red on Figure 7) and they handle both passengers and freight. The two closest lines for freight are (i) the non electrified one from Saint-Dizier to Joinville and Chaumont in the west and (ii) the electrified one that goes through Bar-le- Duc in the north. There is also a one-way non electrified line (in green) that goes along the Ornain valley from Gondrecourt-le-Chateau to Ligny-en-Barrois and then to the main line from Bar-le-Duc; this local line is operated for some freight transports. Two former railways now out of service (in yellow) give a hint of possible new railway paths for some repository locations.



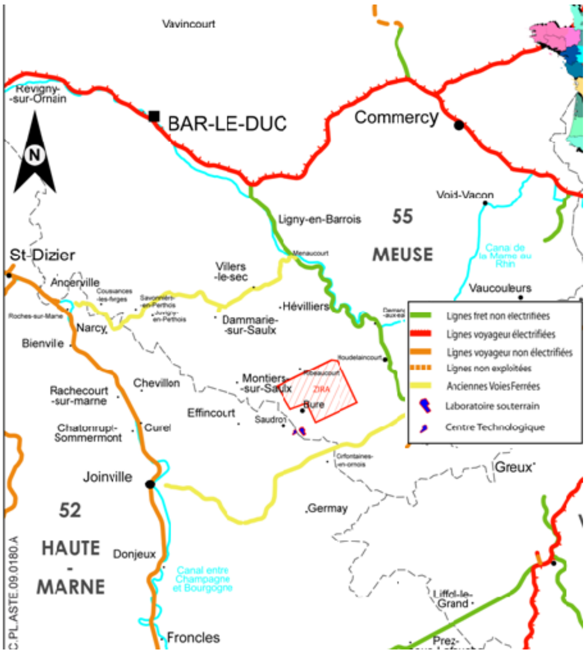


Figure 6: Road network in the vicinity of the Meuse/Haute-Marne site

Figure 7: Railway network in the vicinity of the Meuse/Haute-Marne site

7.4 Main issues on the future repository site

Discussion on nuclear transport is part of a dialogue with public and local stakeholders. One issue is to describe the flows, the transport modalities, the security, and the future impact of the repository site. The siting process should examine the possible connections of the repository to local infrastructure, the possible location of the rail terminal, the necessary improvements of the infrastructure and the cohabitation of these flows with local life and activities.

Another issue is the optimization of transport devices with regard to cost, repository operation and local impacts. This leads to also analyzing buffer storage capacity on the repository site.

8 CONCLUSIONS

Transport is a key factor in nuclear operations. Anticipation of the needs is compulsory in order to prepare the insertion of the repository in the best possible way, and to provide the community with a reliable solution for waste transfer.

The dialogue with local stakeholders for the siting process and the repository acceptance must include a clear strategy for managing transports to the repository and taking into account their local impact. A sustainable development approach on these transports and the technical conditions required for transporting Type B casks indicates a preference for railway transport for this flow.

9 ACKNOWLEDGMENTS

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