# NUCLEAR FUEL TRANSPORT: THE SPECIAL CASE OF SPENT FUEL TRANSPORT

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**Abstract**

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Nuclear transport constitutes for Cogéma an essential activity linking the various components of the fuel cycle. It is thus extremely important for Cogéma to have viable transport systems, in terms of safety of course, but also as regards the reliability of the services granted to its customers. The paper deals in particular with spent fuel transports for which, as a result of the development of its reprocessing plants, particularly that of La Hague, Cogéma already has significant means available. The following aspects are presented: (a) industrial aspects (industrial policy, industrial arrangements); (b) technical aspects (qualification of the fuel, technical options adopted, developments presently under consideration); (c) safety aspects; (d) economic aspects (quantities transported, personnel involved, transport equipment and associated facilities).

## 1. INTRODUCTION

Cogéma, which is a company involved in the field of the nuclear fuel cycle, is of course deeply concerned with nuclear transport activities since nuclear transports constitute essential links between the various industries in the fuel cycle: mining, refining, conversion, enrichment, fuel fabrication, reprocessing, etc.

It is quite natural in this context that Cogéma has a great interest in transport activity but it is also extremely important because Cogéma needs to have viable transport systems in terms of both safety and also the reliability of the services granted to its customers and to its plant operators, in different parts of the world, for the smooth supply of their plants.

There is a great variety of forms of uranium and other materials to be transported throughout the fuel cycle and it is impossible to review them all in a short presentation. This paper deals more particularly with spent fuel transports. There are two main reasons for this choice:

(1) Cogéma has important means (assets, organization, etc.) for the transport of spent fuel as a consequence of the development of its reprocessing plants, particularly that of La Hague; and

(2) The nature of the material transported results in particular features (complexity of the equipment, safety aspects, etc.) which make this activity worthy of special attention.

## 2. INDUSTRIAL ASPECTS

### 2.1. Industrial policy

Cogéma does not intend to operate by itself, directly and systematically, all transports of all kinds in the fuel cycle and likes to rely upon qualified companies working in this field. It likes, however, to supervise all those involved in the transport field, especially when they have a monopoly or when the particular transports considered present some special features (political and industrial implications, important safety risks, etc.).

This is true specially for spent fuel transports to the La Hague and Marcoule reprocessing plants, which Cogéma wants to control extremely closely since a spent fuel transport accident, or even an incident not resulting in nuclear hazards, might totally jeopardize a complete sector of the nuclear industry since:

- owing to the high nuclear risks involved, an accident during a spent fuel transport might result in the prohibition of all such transports for an unlimited period of time, which would not only damage the reprocessing industry but, as a consequence, could damage the operation of all power plants served by the reprocessing plant;
- owing to the extreme sensitivity of public opinion, an incident on roads or rail lines might result in similar effects.

### 2.2. Industrial arrangements

As indicated above, Cogéma likes to supervise all spent fuel transports, the operation being performed either by Cogéma itself or by an affiliated company, either NTL (Nuclear Transport Ltd) or PNTL (Pacific Nuclear Transport Ltd).

In practice, the spent fuel transports from French power stations are operated directly by Cogéma using its own equipment (casks, wagons, trucks, etc.) and assisted only on some sites by Transnucléaire (TN).

Transports arising from other European power plants are operated by NTL, an indirect subsidiary of Cogéma through Transnucléaire , acting for transports to La Hague as a subcontractor of Cogéma and operating for some transports with its own fleet of casks and wagons and using those of Cogéma for the other transports.

Transports from Japan to La Hague, like those to the BNFL plant of Sellafield (UK), are operated by PNTL (in which Cogéma is a shareholder) acting on a contract basis for the Japanese utilities. Cogéma can supervise the conditions under which the fuel is transported to La Hague.

This system makes it possible to have at the same time

- a very good service for all partners involved
- an organization fully adapted to the context (domestic, international, land or maritime transports)
- a high degree of safety and security.

## 3. TECHNICAL ASPECTS

### 3.1. Qualification of the fuel

It is a matter of fact that when, after their discharge from the reactor core and a preliminary cooling in the reactor pond, the fuel elements are made available for transport, their quality (soundness of the cladding, strength of the structure, occurrence of deposits on the surface, deformation, etc.) needs to be assessed so that risks are not taken by the transporter and later on by the reprocessor when cask unloading takes place.

This is necessary from both the transport and cask unloading points of view. In practice, Cogéma has defined, for example, various procedures depending on the power plants (PWR, BWR) and their equipment (in-core sipping, out-of-core sipping), the implementation of which is audited by Cogéma. These procedures make it possible to estimate the degree of soundness of the cladding and/or the existence of possible leaks from the fuel when it is leached by water during transport or, in the case of dry transport, during the water filling of the casks before unloading.

### 3.2. Technical options and design criteria adopted

#### *3.2.1. Big casks*

Taking into consideration the experience gained in the mid-sixties for gas cooled reactor fuel and the mid-seventies for LWR fuel Cogéma has decided to use only big casks instead of small or medium sized casks: reduction of exposures to personnel, reduction of the number of personnel required and also, for new units, reduction of the sizes of the cask unloading facilities – all these are factors leading to substantial cost savings at the reprocessing plant and, as shown by experience, on the transport side too.

*3.2.2. Rail or sea transports*

As a rule, Cogéma and its associated partners (NTL and PNTL) use mainly rail and sea transport and, with a few exceptions, use road transport only for very short distances between certain power plants and a rail/road terminal built in their vicinity or a port terminal for stations, built along the seashore and served by sea.

*3.2.3. Standard packagings*

Cogéma has used and is still to some extent using a large variety of casks. When the quantities to be transported were limited and the reactor equipment and fuel types were far from being standardized, the transports were mainly made in relatively small casks. With the increase in the quantities involved, a certain standardization of plants and fuel around five or six standards, a growing concern about the need to develop remote operations and, if feasible, automatic operations at the reprocessing plant where large numbers of casks have to be handled, Cogéma has decided to impose a number of standards where cask design is concerned.

For acceptance of casks at La Hague there are four standards based on identical design features and differing from one another only by the sizes (weight, capacity, length, diameter): two different diameters and two different lengths are defined but the combination of the small diameter and the long length is not used.

The main design features are as follows:

(1) Dry type, i.e no water in the cavity during transport
(2) Flask suitable for dry unloading and pond unloading
(3) Technical requirements:
  - ability to fit standard protective skirts
  - use of stainless steel coating of a minimum thickness
  - capability of internal and external decontamination by automatic equipment
  - similar unloading procedures
  - maximum capacity
(4) Adoption of many standards for shapes, materials (for trunnions, orifices, covers and lids, screws and bolts) and, in general, all dimensions of interest for the cask operations.

The main advantages of these packagings are their large payloads, their moderate costs, their reliability resulting from extensive experience, and the consequences of standardization for fabrication, operation and maintenance, i.e. a series of factors extremely beneficial from a safety standpoint.

### 3.3. Developments presently under consideration

The evolution of the designs in the years to come will be dictated by two main factors:

(1) Fuel evolution: the gradual increase in the burnup and the progressive introduction of plutonium recycling (MOX fuel) are likely to impose higher shielding and heat dissipation capability partly offset, however, by longer fuel cooling times before transport;

(2) The increase in the transport demand following the launching in the Federal Republic of Germany and Japan of large reprocessing programmes (Wackersdorf and Shimokita) will probably result in the entry into service of large fleets of casks with designs adapted to specific requirements, mainly the cooling time of the fuel transported and the residence time of the fuel in the casks.

The first factor will of course affect the design of the casks used by Cogéma as many customers of La Hague reprocessing plant intend to deliver high burnup fuel and MOX fuel. The second will probably not affect the criteria adopted by Cogéma as Cogéma customers wish to have their spent fuel transported after a rather short cooling time and are rather satisfied by the present systems.

## 4. SAFETY ASPECTS

Transporters have to comply with many different regulations: French regulations for the transport of radioactive materials within France, ADR, RID and IMCO regulations for international transports by road, rail and sea and all other regulations specific to each country, such as, for example, the French steam pressure rules as the casks may be pressurized during the unloading process at La Hague.

The basic contents of all these various texts are largely common, their respective authors having always followed in the drafting of the texts the recommendations laid down by the IAEA and having mainly adapted the presentation to the structure of the regulations without significant alteration. This situation is very fortunate and worth noting: the universality and the relative stability of the extremely severe criteria that the transporters have to apply in their activity, and in particular in the design of the packagings, are great safety factors. Packagings licensed in a particular country have a very good chance of having their certificates validated in other countries when the need arises.

Experience and analysis have shown that the casks actually used for the transport of spent fuel have a large margin of safety with respect to the regulatory tests and the real conditions they may meet.

TABLE I. SPENT FUEL TRANSPORT ACTIVITY

| | | | |
|---|---|---|---|
| GCR | 1966/1985 to La Hague | 4780 t U | 1580 casks |
| | 1975/1985 to Marcoule | 2440 t U | 510 casks |
| LWR | 1973/1985 to La Hague | 4120 t U | 1540 casks |
| FBR | 1968/1985 to La Hague | 10.6 t U + Pu | 125 casks |

The impact test at a speed of 50 km/h on to an unyielding surface is equivalent to a highway or rail crash well in excess of 100 km/h owing to the fact that there is no unyielding surface in highway or rail transport conditions. Crash tests have demonstrated the ability of the currently utilized casks to withstand conditions more severe than those of the regulatory tests.

Evaluations of the behaviour during fire tests of portions of casks have indicated that the cask seals reach a temperature where there is a possibility of leakage only after a period much longer than the 30 minutes of the regulatory test.

## 5. ECONOMIC ASPECTS

### 5.1. Quantities transported

The figures in Table I illustrate the economic impact of the spent fuel transport activity correspond to a programme of more than 200 GW(e)·a from a combination of GCR, LWR and FBR plants.

Considering only LWRs, the coming 10 years will lead to the transport to La Hague of about 13 000 t U in about 3000 cask movements to serve approximately 110 reactors, half of them being French. In 1986 for example, it is expected that 300 cask movements to La Hague will be carried out – 200 by rail, 50 by sea and 50 by road.

### 5.2. Personnel involved

The personnel involved in the spent fuel transport is small: Cogéma, NTL and TN staff dealing with spent fuel transports to La Hague amount to less than 100 people for design, procurement and purchase, operation, maintenance, supervision and management. Of course other partners contribute to this activity to various extents – railway personnel, ship crews, port personnel and truck drivers, for instance. However, in total, as compared to other areas of the fuel cycle, the personnel working in this field is relatively small.

### 5.3. Transport equipment and associated facilities

The transport of spent fuel is not a very spectacular activity: no big facilities, no remarkable equipment, everything being relatively small and dispersed in many different places (roads, railway lines, sea routes, etc.). However, the equipment is quite extensive and represents very significant assets. Considering again only LWR spent fuel, we can list the following:

- about 90 big casks owned by Cogéma, NTL and PNTL
- about 30 rail wagons owned by Cogéma and NTL
- several special ships (five ships owned by PNTL operate between Japan and Sellafield and La Hague)
- a few very special trucks owned by Cogéma
- a private rail terminal near Cherbourg owned by Cogéma, with facility to maintain wagons and trucks, and a port terminal at Cherbourg
- a facility for the maintenance and reinspection of all casks at La Hague.

## 6. CONCLUSION

Transport of spent fuel represents a comparatively small turnover as compared with the other services of the nuclear fuel cycle (about 5 to 10% of the reprocessing costs, for instance, and in general not more than 0.4 to 0.7% of the cost of nuclear electricity generation). Nevertheless, transport is indeed an essential part of the fuel cycle and partly controls the operation of the downstream facility (reprocessing plant) and of the upstream ones (power plants).

All matters related to spent fuel and spent fuel management are quite sensitive, as everyone knows: this is due not only to political factors but also to the particular risks involved and the very serious impact on public opinion of any incidents. This is especially true of the transport of spent fuel since transport is the only step in the fuel cycle which takes place outside a nuclear facility – on public roads, railways or open seas, where incidents or accidents would eventually involve not only the environment but also the public and subsequently might result in the risk of jeopardizing all or part of the nuclear industry.

Despite the large number of shipments already carried out to Cogéma plants and to other reprocessing plants throughout the world, no accidents have happened in which persons have been injured or property damaged as a result of the radioactive nature of the materials. The reason for this lies in the very high level of safety which, as in all areas of the nuclear industry, applies to the transport of irradiated nuclear fuel.

The figures given above show that considerable experience has been gained in this field. In summary:

- 300 transports to La Hague, LWRs only, in 1986, i.e. approximately 1200 t U.
- every day, on average, two ships, a dozen rail wagons and two trucks carrying casks loaded with irradiated fuel are moving in various countries, bound for the La Hague reprocessing plant.

Skilled personnel are working so that this activity continues, as in the past, safely and with discretion.