

SPENT FUEL TRANSPORTS IN FRANCE LESSONS LEARNED FROM 1998 CRISIS

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ABSTRACT

In May 1998, all French domestic transports of spent fuel assemblies from EDF Nuclear Power Plants to the COGEMA Reprocessing Plant (about 200 transports per year) were temporarily suspended because a significant fraction of those transports showed levels of non-fixed surface contamination exceeding at the arrival the routine regulatory limit of 4 Bq/cm² for β and γ emitters. Abroad, Germany and Switzerland also suspended this type of transports.

Under the supervision of the French Nuclear Safety Authority (DSIN), in charge of monitoring radioactive and fissile material for civil use since June 1997, the introduction of improvements in terms of preparation of the flasks, contamination measurements and rules for exchange of information, enabled the resumption of transports in France in July 1998. Abroad, transports also resumed in Switzerland in August 1999, and in Germany in April 2001.

The detailed analysis of this event pointed out that:

- the recorded levels of surface contamination exceeding 4 Bq/cm² did not have any radiological consequence as far as health effect is concerned ; in fact this limit is a derived limit which has substantial safety margins in the modeling underlying its derivation, and the limit can rather be depicted as a cleanliness goal,
- the design of the flasks was demonstrated not to be a cause,
- conventional techniques for protection, handling, loading and unloading of the flasks can and do lead to acceptable results.

This paper describes the lessons learned from this event, especially in terms of:

- techniques to be shared by Nuclear Power Plant operators and Reprocessing Plant operators for protection, handling, loading and unloading of the flasks,
- overall responsibility of safety and radiological protection which has to be fully taken by the operators (as consignors of such shipments) up to the arrival of the shipment at destination,
- education and information of all parties involved in such transports (railways workers for instance).

Their implementation leads to a dramatic reduction of the number of cases of exceeding the regulatory limits: from 35% before the stop of the transports down to 2% of the about 200 transports performed in 2000. In addition, it should be noted that for these few cases, the limits were only slightly exceeded.

INTRODUCTION

Each year, approximately 200 spent fuel packages leave EDF nuclear power plants for the COGEMA reprocessing plant at La Hague. These packages are almost all transported by train to the rail terminal at Valognes, owned by COGEMA, then by truck to the COGEMA reprocessing plant at La Hague, 30 km away. During the journey, they are covered under a locked canopy, or a tarpaulin, and not accessible from the outside

The regulation requires controls be made at the departure with a limit set in the regulations at 4 Bq/cm² for non-fixed contamination by β and γ emitters. These controls were always made and all the results were reported under the regulatory limit when leaving the nuclear plants. Nevertheless, at the arrival of the convoys some points in excess of these limits were recorded and actions were engaged to find proper solutions. In 1997, 35% of convoys used by EDF recorded surface contamination, on at least one point of packages and/or wagons arriving at Valognes, in excess of the regulatory limit, most of them, except in a few cases, on non accessible parts, within the canopy which encloses the flask <1>.

The Nuclear Safety Authority (DSIN), which had taken charge of the nuclear transportation since June 1997, was informed of this issue and preventive measures were implemented to improve the situation. This problem was made available to the public in early May 1998. On May 6, with EDF and COGEMA's agreement, SNCF (the French railway company) decided to suspend all rail transports of spent fuel whilst awaiting further information on the radiological impact due to the contamination of convoys.

On May 13, 1998, the French Nuclear Safety Authority (DSIN) submitted a report <2> to the Prime Minister on the contamination incidents. This report established that the incidents had not had consequences for health, but reflected a lack of cleanliness at plants operated by EDF, due to slackness in operating, facilitated by the lack of any real government monitoring until several months ago.

This was later confirmed by various independent assessments in France, but also in Germany, Switzerland and United Kingdom (<4> and <5>). They have come to the conclusion that, as far as health effects are concerned, the recorded non-compliance with the 4 Bq/cm² guidance level did not have any radiological consequence.

The Office for Protection against Ionising Radiation (OPRI) carried out monitoring of SNCF workers: the radiation levels from artificial sources in their bodies were not in excess of the detection limit. This confirmed that the recorded surface contaminations do not have any consequence for health.

In addition, it was generally agreed that the levels for non-fixed contamination as specified in the international transport regulations are derived limits which have substantial safety margins in the modelling underlying their derivation, and can rather be depicted as cleanliness goals.

CAUSES

It had been proved that surface contamination is not caused by leakage from interior of the flasks. The cases of contamination found on the surfaces of transport flasks for spent fuel assemblies are linked to the loading of the transport flasks in the spent fuel pools of the nuclear power plants. In the cooling circuit and in the spent fuel pools of nuclear power plants, radioactivity exists both in dissolved form and in the form of particles originating from corrosion and abrasion.

Three possible reasons were identified for the contamination levels measured at arrival points:

- activity which was fixed at the time of pre-despatch smear sampling may, in the course of the journey, have become non-fixed (a phenomenon known as "sweating" or "weeping");
- some non-fixed activity may not have been detected by pre-despatch smear sampling, possibly because it was in areas that are difficult to decontaminate and/or monitor, and
- some contamination may have occurred between pre-despatch monitoring and monitoring at the arrival point, e.g. from contaminated equipment used in loading or unloading flasks.

Flasks with cooling spikes (like TN flasks, used in France and abroad) or flasks with cooling fins (like NTL flasks, used abroad) are both concerned. As regards the frequency of contamination events, there is clearly no indication that one type of flasks performed worse than the other type of flasks <4>.

There is a common understanding that conventional techniques of protection of the flasks during loading, of decontamination after loading and improved measurement techniques can lead to acceptable results. But additional protective measures should also be considered <5>.

ACTIONS PERFORMED

Measures to prevent from contamination

A booklet of "good practices" had been prepared and issued by experts of Transnucléaire and EDF for handling and operating flasks. It had been broadened to all the plants.

Cleanliness actions were also generalized to the tools (skirt, plug, connecting pipes...). They are systematically cleaned before and after each loading of fuel assemblies.

Handling devices are also regularly checked to prevent any cross-contamination.

Checking of artificial radioactive contamination of all the EDF and COGEMA railway terminals and all the meeting points for EDF plants with branch lines is also regularly performed.

Harmonisation and improvement of contamination monitoring procedures

Procedures for contamination monitoring, measuring and cleaning were compared, reinforced and harmonised between EDF and COGEMA. Contamination monitoring is made using a double step procedure with a whole screening of the equipment and a detailed localised regulatory sampling on a definitive number of specific points. The points of control both on the flasks and the vehicles are increased.

Shelters were built on COGEMA railway terminal so that rail/road transfers and flasks, wagons and trucks monitoring take place independently from weather conditions. The same is on schedule for all the EDF railway terminals.

Enhancement of the consignor responsibility

In providing written commitment to SNCF, based on its own Quality Assurance system, the consignor site management confirms the cleanliness of the consignment and the application of good practices without cleanliness faults <3>.

Through information provided by Transnucléaire (as flasks designer, manufacturer and maintenance operator), the consignor takes the full responsibility of the consignment, as required by the domestic and IAEA regulations.

Moreover in a case of a level of contamination exceeding the regulatory limit, the information to the Nuclear Safety Authority and the public is supplied by the consignor.

Currently, in agreement with SNCF, to reinforce the contamination monitoring procedures and the consignor cleanliness guarantee, a non-contamination check by a third-party company is also provided before each rail departure. This company is certified by the Ministry of Health. This non-compulsory action will be carried out till it is considered no more useful by all the relevant organisations, including SNCF.

Reporting

In case of a level of surface contamination exceeding the regulatory limit, the results are fully recorded and double-checked by a third-party company.

An immediate information is then provided to the consignor, the consignee and all the operators involved in the transport: SNCF for rail transports and Transnucléaire subcontractors for road transports and rail/road transfers.

The consignor immediately brings information to the French Nuclear Safety Authority (DSIN). The importance of the event is balanced according to its risk significance and the accessibility of the contaminated surface. A graded set of levels to describe the severity of contamination events is applied. For β and γ emitters, it is classified as follows:

For flask	> 4 Bq/cm ²	Declaration of an event.
	> 100 Bq/cm ²	Declaration of a significant incident with detailed report.
	> 400 Bq/cm ²	Declaration of a significant incident with detailed report, as well as public announcement.
For wagon	> 4 Bq/cm ²	Declaration of an event.
	> 50 Bq/cm ² (1000 Bq/cm ² for a part of the wagon not accessible to the public, known as drip-tray)	Declaration of a significant incident with detailed report.

Table 1

Furthermore, a public announcement is made in every case in which accessible parts to the public or the workers are contaminated above the limit.

At the European level, an International Data Base on spent fuel shipments has been set up and maintained by the German organisation GRS.

Information and education

Information about radioactivity and associated risk was also provided to SNCF workers and trade-union organizations.

In the mean time, visits of the COGEMA and EDF railway terminals were also organised and explanations about flasks, transport organisation and operating process were given.

The results of the checks of artificial radioactive contamination of all the EDF and COGEMA railway terminals, and all the meeting points for EDF plants with branch lines, which are regularly performed, are transmitted on a quarterly basis to SNCF.

RESUMPTION OF TRANSPORTS

The Nuclear Safety Authority proceeded with systematic inspections of all plants before resuming spent fuel transports. The inspections dealt, among others, with organization, quality control, monitoring, procedures and cleanliness of the equipments.

The spent fuel transports resumed in July 1998 in France.

Meanwhile, the Office for Protection against Ionising Radiation carried out various types of monitoring in order to satisfy SNCF management requirements: further to the monitoring of the radiation levels from artificial sources in their bodies, some SNCF workers were temporarily equipped with a personal dosimeter and radiological checks around rail-wagons loaded with spent fuel flasks were performed. The conclusion was that there was no justification for classifying SNCF workers as nuclear workers (Category A and Category B, within the radiological protection terminology). Nevertheless, optimisation measures were taken to still reduce the external exposure of SNCF workers to radiations and improve information.

As a consequence of all the measures described above, the number of convoys with one point (or more) with a level of surface contamination exceeding the limit was dramatically reduced. The situation, over the years, is as follows, for the transports leaving EDF power plants:

Year	Number of transports	Percentage of overtaking the limit
1997	207	36 %
1998 before the ban	90	20 %
1998 after the ban	69	12 %
1999	156	5 %
2000	191	1.5 %

Table 2

After the resumption of the spent fuel transports, the maximum level of surface contamination exceeding the limit is as follows:

Year	Maximum surface contamination
1998 after the ban	716 Bq/cm ²
1999	104 Bq/cm ²
2000	66 Bq/cm ²

Table 3

These results demonstrate that the surface contamination is now a well-mastered phenomenon. They enable to improve the reliability of the spent fuel shipment process.

FURTHER ACTIONS

Several actions are still under progress for optimising the operations described above. Some of them are listed below:

- Meetings between various operators or experts from COGEMA, Transnucléaire and EDF (and also other European utilities) take place on a regular basis in order to share experience gained by each one for handling and loading flasks.
- On each nuclear power plant, a skilled technician, especially qualified in the area of nuclear transports, is trained to supervise all operations related to the consignment of nuclear materials, in compliance with regulations.
- Detailed technical explanations of the key-points related to safety and cleanliness are provided by Transnucléaire. The operators in charge of the consignments will take them into account to optimise their operating modes for the flask preparations.
- Based on the analysis of the radiation exposure of the workers in charge of the contamination monitoring, optimisation of the monitoring procedures has to be performed in accordance to the ALARA principle, to avoid undue doses to workers. A study is currently under progress. The French industry is deeply involved in this study, which is sponsored by the European Commission. It should provide useful information in this field.
- In lights of the recent events in Europe, IAEA proposed a Co-ordinated Research Program (CRP) on the radiological aspects of package and conveyance non-fixed radioactive contamination. Because the wording in successive editions of the Regulations has changed, with growing emphasis on establishing limits, different Member States have interpreted these limits differently. In view of this and the associated assessments of the risks posed by the events in Western Europe, the current non-fixed contamination limit requirements may need to be reconsidered, with the goal of ensuring that the values given to the criteria and the way in which the criteria are described are consistent with their intended application. The CRP is now launched, with the participation of experts from France, Germany, Japan, Sweden, United Kingdom and USA.
- Research and development actions in EDF are in progress to set up industrial methods to improve cleanliness as earliest as possible in the process of flask loading. It especially concerns the fuel assemblies, the water of the loading pond and the flask in the pond (e.g. ultra-sonic cleaning, electrical field)
- The designers of new flasks have to take into account the experience gained to reduce the risk of contamination and facilitate the decontamination.
- It is necessary to develop openness for the public and for the railway companies and in reporting to the regulatory authorities, within a harmonised risk informed framework to enable a prompt and risk-graded information and treatment in case of non-compliance. It is also necessary to bring to all involved transport companies relevant education and information about the nature of risks and of preventive measures implemented.

- Guidance has been provided by the French Nuclear Safety Authority (DSIN) to facilitate the implementation of the International Nuclear Event Scale (INES) in the field of transport. To implement INES for transports is now a common practice in France and participates to the effective information, mentioned here above. To broaden worldwide the use of INES to transport would allow a consistent information in case of an event that involves several countries.

CONCLUSION

The actions performed and the results obtained demonstrate that the surface contamination is now a well-mastered phenomenon.

The reliability of the spent fuel shipment process is then considerably improved. But, whatever successful the improvements are, it is necessary to maintain the efforts at the highest level. Implementation of the ALARA principle is now the next step to be performed to optimise the process.

Utilities need a reliable and predictable transport system. Regulations and associated comments should make clear the nexus between regulations, health and safety goals and risk assessment. This will lead to a better understanding for the public and ensure reliability and stability of the regulations.

REFERENCES

- <1> Surface contamination of spent fuel convoys. Resumption of transport in France – V. PERTUIS (DSIN) - Top fuel, Avignon 1999
- <2> Rapport au Premier Ministre en date de 13 Mai 1998
- <3> Spent fuel transportation – Lessons drawn and ways forward: European utilities prospective - M DEBES (EDF), G.J. SCHIMMELE (ENBW), H. SANNEN (TRANSNUBEL), H. PATAK (ELECTRICITY OF LAUFENBOURG) - International symposium on technologies for the management of radioactive waste from nuclear power plants and back end fuel cycle activities, Korea 1999.
- <4> Contaminated spent fuel flasks: problems and solutions in Germany and in France - F. LANGE (GRS), G. SERT (IPSN), B. LAURENT (IPSN) - Eurosafe, Paris 1999.
- <5> Surface contamination of nuclear spent fuel transports. Common report of the Competent Authorities of France, Germany, Switzerland and the United Kingdom - Paris, 24 October 1998.