

Lessons learnt from transport events and inspections involving radioactive material in France between 2007 and 2011

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ABSTRACT

The French Nuclear Safety Authority (ASN) analyzed the feedback from all inspections and events related to transport between 2007 and 2011. Lessons learnt from more than 400 inspections and 500 events have been identified. In addition, the French Institute for Radioprotection and Nuclear Safety (IRSN) has conducted a systematic review of the 1 300 transport events recorded since 1999.

These analyses cover all phases of transportation (preparation of the package, consigning, loading, carriage, manufacturing of the packaging, etc.), all modes and all sectors of use.

The number of declared events with potential consequences on the safety or radiation levels slightly increased over 2007-2011. In particular, non-compliances with type B package approval certificates were reported by nuclear power plants and require additional preventive measures from the designers and users of these packages, in particular the verification of absence of inadvertent contents.

Human errors and organizational deficiencies were the cause of many deviations observed during inspections. The consistency between the safety report and the actual operations should be improved through organizational measures and more user-friendly documents.

Improvements are also needed in the following areas: the conformity of non-approved type A and industrial packages, the training of workers transporting and handling radioactive materials for medical and industrial uses and the preparation of packages prior to transport.

The actions planned by ASN to prevent recurrence or reduce the potential consequences of events are presented.

INTRODUCTION

900 000 radioactive packages are estimated to be transported in France every year. Nuclear industry represents only 15% of these packages. The other packages are transported for non-nuclear industrial or medical uses.

The French Nuclear Safety Authority (ASN) performs every year about 100 inspections in order to control these transports. To have a better knowledge of the transport safety, ASN and IRSN (French Institute for Radioprotection and Nuclear Safety) also analyze regularly the events notifications sent by the various operators in case of incidents or non-compliances.

According to the number of transports and considering that no major accidents have been reported (according to the INES definition), ASN considers that the safety of the transport of radioactive material in France is quite satisfactory overall. However, in order to continuously

improve the safety, efforts should be maintained. Lessons have to be taken from the notified events and from the inspections performed and the associated corrective actions have to be implemented.

In 2012, ASN analyzed the feedback from inspections and events related to transport between 2007 and 2011. Lessons learnt from more than 400 inspections and 500 events have been precisely identified. In addition, IRSN has conducted a systematic review of the 1300 transport events recorded since 1999. These analyses cover all phases of transportation (preparation of the package, consigning, loading, carriage, manufacturing of the packaging, etc.), all modes and all sectors of use.

On the basis of these two analyses, areas for improvements were identified and an action plan has been built in order to prevent recurrence or to reduce the potential consequences of events and to improve the safety of transports.

INSPECTIONS AND EVENTS NOTIFICATIONS CONSIDERED

Inspections

ASN performs inspections at every step of the transport process (manufacture of packagings including those for non-approved packages, drop and fire tests, maintenance, shipment, carriage, etc.). Following each inspection, a letter asking for remedial actions is sent to the inspected company and published on the ASN website.

The current distribution of the inspections according to topics is shown on figure 1. This number of inspection by topic can be adjusted every year to take into account the feedback from last events and inspections as well as the need to control the implementation of new regulatory requirements, as applicable.

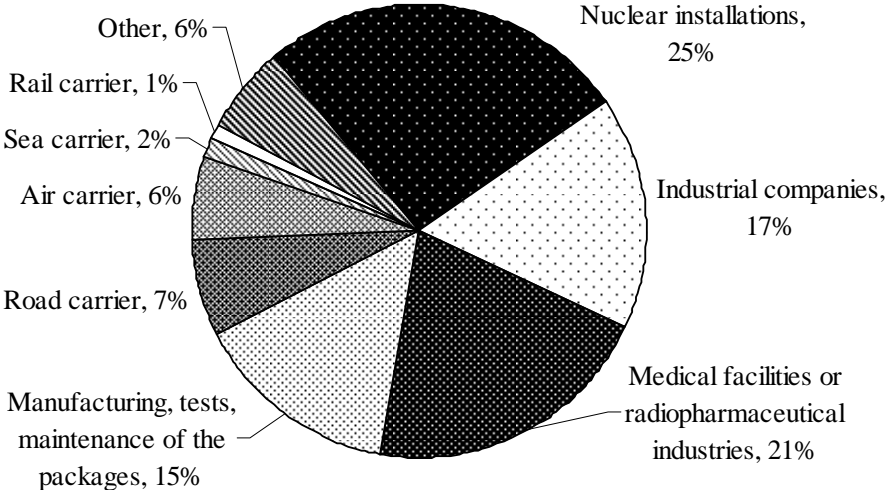


Figure 1 – Distribution of ASN transport inspections

Events notifications

Since 1997, French consignors have to notify the competent authority of every event occurring during transport of radioactive materials. This requirement covers all modes of transport (road, rail, air, sea and inland waterways) as well as the associated operations: manufacture, loading, unloading, in-transit storage, maintenance and intra/intermodal transfer. The non-compliances concerned by these events are described on figure 2.

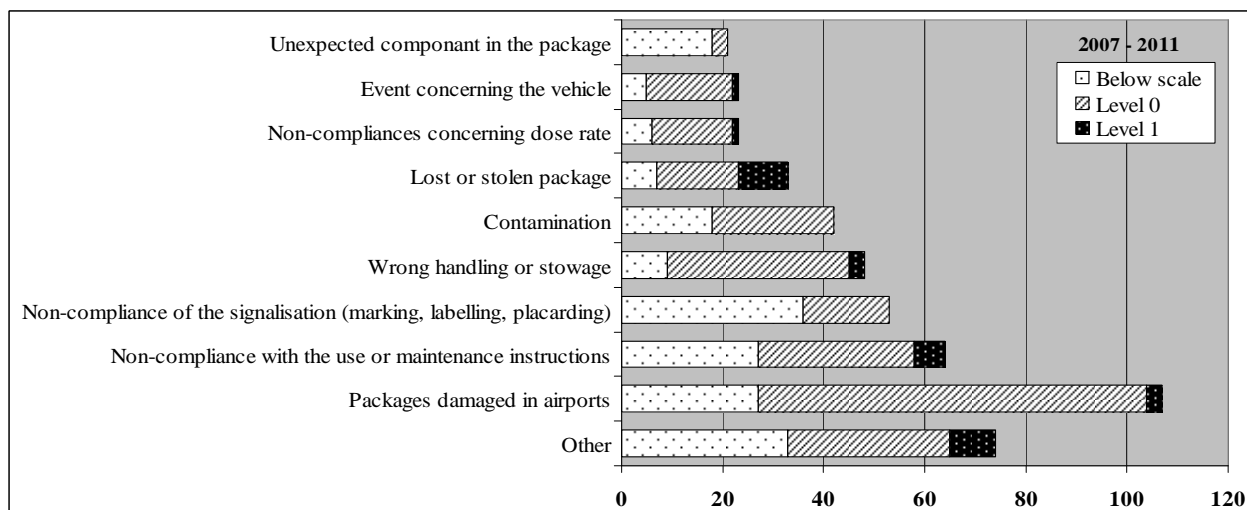


Figure 2 - Distribution of the event notifications according to topic between 2007 and 2011*

* Since 2000, only two events have been rated at a level higher than 1:

- One level 3 event occurred in 2001 concerning an international air transport of sources;
- One level 2 event occurred in 2012 concerning a domestic transport of a ^{18}F package.

Around 100 events are notified every year, without clear tendency over time. Most of them (about 90%) are “below scale events” or INES level 0 events. Though less important, these events may be particularly interesting as their repetitive nature could be the precursory sign of a situation requiring a thorough analysis and corrective measures. These “weak signals” should be suitably interpreted in order to avoid the occurrence of more serious events. As they are of low importance, the notification practices of these types of events could vary between the different consignors of radioactive materials. ASN regularly reminds all operators of the importance of notifying and analyzing them.

MAIN OBSERVATIONS CONCERNING NUCLEAR FACILITIES

Improve the compliance of packages with the approval certificates and the safety report

Non compliances in the preparation or the use of packages with potential consequences on the safety or radiation levels were largely notified to ASN over 2007-2011:

- non compliances of the content (for example, presence in packages of items which are forbidden by the approval certificate, such as plastic materials (vinyl protection around the content or straps in order to handle fuel rods) or liquids (water due to inadequate drying or oil) which could lead to the production of flammable gas through radiolysis or thermolysis) or disperse contamination;
- non compliances concerning the packaging (non-tightened screws, wrong seals, omission of lead protection or of protection plate on orifices...);

- non compliances concerning the instructions for use, for example a type B package, handled with a forklift truck, fell when it was unloaded from a truck. The package has no user manual and this type of handling was forbidden by the safety analysis report;
- non compliances concerning the shipment (permutation of two packages leading to the transport of a non-authorized package or leading to the transport of a package with inadequate documentation, inversion between an empty and a fresh fuel package);
- non compliances concerning the controls before shipment, for example a spent fuel package has been shipped by road from a nuclear plant while its dose rate at 2 meters was above 0,1 mSv/h. The value was correctly measured but not identified as exceeding the regulatory limit. Some other measures made some 10 km further (where the package was supposed to be moved on a wagon to be transported by rail) permitted to detect the non compliance.

Human errors and organizational deficiencies could be the cause of some of these non compliances, but other explanations could be pointed out:

- insufficient communication between the various operators (applicant, shipper, package owner, etc.). Inspectors have noticed that several shippers do not have the instructions to properly use the package or do not have the latest version of these instructions,
- lack of ergonomics of documents (too complicated approval certificate or instructions for use, etc.),
- lack of control of the consistency between the safety report, the user manual and the current operations,
- lack of training of the operators.

In order to reduce deficiencies caused by human error, some operators have developed specific tools. For example, in order to avoid incorrect fastening of elements, some operators have proposed a tool which cannot be separated from a protective plate unless the plate is correctly fastened. ASN has asked all French package designers and users to work together in order to increase such initiatives. At the same time, ASN in co-operation with IRSN, the applicants and the consignors are working together in order to improve the ergonomics of the approval certificates to prevent human errors.

Strengthen controls of non-contamination

In 1998, several cases of contamination higher than the standards were highlighted for packages and wagons transporting spent fuel packages coming from nuclear power plants and going to La Hague reprocessing plant. The doses produced by the contamination for the workers and the population were estimated to remain lower than 1 mSv, even for the worst case exposure scenarios. Nevertheless, transports of spent fuel were stopped until stricter decontamination and control methods were implemented in the nuclear power plants to prevent from other contamination non-compliances.

Notable progress has been achieved since then, but vigilance should be maintained. In 2011, three cases were detected (among 202 transports of spent fuel).

Cases of contamination have also been detected for other kind of packages (contamination spots up to 100 Bq/cm²). About 30 cases between 2007 and 2011 were notified. They mainly concerned packages which were contaminated on the handling elements or empty packages which were supposed to have been decontaminated. Stricter controls have to be carried out by the operators and have to be checked by inspectors.

Share the feedback concerning the use or the design of packages

In 2011, ASN was informed about a weakness on an overpack used for the transport of UF₆ cylinders. This overpack has been designed by a US applicant and is used all over the world. Several events were reported indicating that some of the ball-lock pins used to close the overpack were found untied during transport.

This notification was reported by different French companies from the same group. An analysis of these events was required by ASN. The inspectors noticed that the feedback from these events was not taken into account in the same way in all the companies and that the corrective measures identified by the designer of the package were different.

A deeper analysis showed that the designer of the overpack had previously pointed out that the initial ball-lock pins had to be replaced by some specific others in order to avoid failure. This information was not communicated to the French users of the package and was not reported in the version of the safety analysis report that was sent to the French competent authority.

Today, all locking pins have been replaced and the feedback of the event has been shared between authorities.

This event had no direct consequences on safety, but it emphasizes the need of international collaboration between the various stakeholders (designers, owners and users of the packages and the authorities) concerning the feedback of the packages.



Figure 3 - Photo from a ball-lock pin

MAIN OBSERVATIONS CONCERNING THE INDUSTRIAL AND MEDICAL FIELDS

Inspectors have observed that industrial and medical users of sources often have an insufficient knowledge of the transport regulation. Shippers tend to rely on the carriers or on their radioelements supplier in order to guarantee the conformity of the packages and are not aware of their responsibility as a shipper of radioactive material. They sometimes do not have radiation protection instruments and the measures are made by the carriers. Workers are insufficiently trained and proofs of the conformity to the approval of the packages asked by the inspectors are often not available.

Inspectors also observe frequent lacks or insufficiencies of the tie-down of packages. The level 2 event notified in 2012 is a good example of lack of tie-down: a package containing a fluor 18 vial was transported by road although it was not tied down and the doors of the vehicle were improperly closed. The package fell from the vehicle. When the driver realized the lost of the package and retrace his route, he could not find the package which may have been picked up. Because of the short life time of the radionuclide, this incident probably had low consequences on a long term for public and the environment.

Some other non-compliances with the regulation are regularly observed by the inspectors:

- lack of radiation protection program,
- lack of safety adviser,
- the periodical check required by the regulation in order to determine the level of contamination is barely realized,
- orange-colored plates are magnetic and do not seem to be resistant to a 15 minutes engulfment in fire.

INCIDENTS AND ACCIDENTS DURING THE CARRIAGE

Few traffic accidents involving radioactive material were reported. Most of them had no impact on the package safety: 15 minor traffic accidents (minor collision or rollover of vehicles transporting medical or industrial class 7 packages), 2 minor engine fires and one derailment of a wagon without consequences were notified.

One level 1 traffic accident occurred in 2007. It involved a vehicle carrying a type B radioactive package containing special form sources. The vehicle, belonging to a German company, collided with an other vehicle transporting inflammable goods. The vehicle containing the package burned completely and both drivers died. Radiological measurements were carried out and showed that there was no contamination and that the package was still operative (see figure 4). While the package resisted under these severe circumstances, it was noted difficulties in determining the proper actions to be done by the emergency response team due to the absence of appropriate consignor and carrier emergency plans.



Figure 4 - Photo from the package after the accident, 2007

IMPROVE RADIATION PROTECTION DURING THE CARRIAGE

The areas of improvement concerning carriage rather concern the radiation protection. All transport modes are concerned:

- during road transports, the doses for the drivers can be very important, particularly for the transport of medical packages,
- in airports, some medical radioactive packages are regularly damaged because of rough handling conditions or lack of tie-down,
- in case of air or maritime transport, operators are not familiar with the handling of radioactive packages. Operators may not have the appropriate tools. Handling operations can be very long, involve many operators and be very dosing. Moreover people are sometimes not aware of the effects of radiation.

Lack of Radiation Safety Officer in the carriage companies is also noticed.

Some improvements and good practices have been noticed in few big transport companies concerned by a high number of transports, but most of the time, progresses have to be done.

AVOID NON COMPLIANCES DURING THE MANUFACTURE OF PACKAGINGS

A default during the manufacture of a packaging could affect the transport safety. During inspections, organizational and technical means for the manufacture of packaging seem satisfactory overall. The main observations during the inspections concern quality insurance (for example, lack of traceability, no audit of the suppliers or insufficient communication between the designer and the manufacturer). However other kind of non compliances were also noticed, for example deviations concerning the dimensions of a seal groove or concerning screw threads.

Few non compliances are noticed but they point out that the problem of the consistency between the safety report and the current operations does not only concern the shipping operations as previously explained, but also the manufacture of packagings.

Manufacture of industrial and type A packages is also controlled. After a TranSAS mission in France in 2004, ASN has intensified the control of the manufacture and the shipment of these packages. During these inspections, the conditions and the representativeness of the tests are checked and the safety demonstrations examined. Improvements still have to be made, as these elements are often incomplete and do not comply with the requirements of the regulation recalled in an ASN guidance published on ASN website.

ANALYZE THE FEEDBACK FROM THE MAINTENANCE OF PACKAGING

Some non-compliances have been noticed during maintenance inspections: non respect of the maintenance periodicity, lack of traceability, insufficient control of the sub-contractor or differences between the maintenance instructions and the safety analysis report.

ASN has also noticed that applicants requiring a package approval may have bad knowledge of the feedback of the maintenance of the package. They are responsible of describing the use and maintenance instructions in the safety analysis report but they may have few feedback about it because they do not own or use the packaging and because the maintenance operations are often made by someone else (the owners or users of the package or a subcontractor), possibly abroad.

ASN has updated its “applicant’s guide” in order to request an analysis of the feedback from the use and maintenance of the packages in the safety report.

EMERGENCY PREPAREDNESS

Inspectors have noticed that very few operators have planned measures in case of an incident or accident involving a transport of radioactive material (“appropriate measures” required in §1.4.1 of ADR). Moreover the existing procedures are often incomplete and only a few exercises are organized.

The feedback from these exercises shows that :

- the risks linked to the content could be hard to identify, particularly in case of a fire as placards and documents may be destructed or illegible. Identifying the carrier and the consignor in order to get more information about the loading can be difficult too.

- contrary to people living near nuclear facilities, in case of a transport accident, people and media around the place of the accident may not be aware of the risks and of may not know the instructions of sheltering and listening. Moreover there may be no warning system.
- obtaining reliable information can be very long. First decisions may have to be taken without it.
- exercises involving a transport of radioactive material involve many organisations on both local and national levels, which, de facto, restrict the number of exercises that it is possible to plan and the number of stakeholders involved.

Emergency preparedness has to be reinforced thanks to appropriate measures, training and exercises. France will soon publish a guide describing what is expected from the operators in case of an incident or accident in order to help them at developing emergency procedures and will propose a modification of the international transport regulation in order to clearly request consignors and carriers to have emergency procedures.

CONCLUSION

Given the large number of packages transported, the level of safety of the transport of radioactive material in France is considered to be relatively satisfactory. However seven areas for progress are identified :

1. Organizational and Human factors

Organizational and human factors must be taken into account and strengthened at each step of the transport process.

Organizational and Human means should be sufficient to ensure the conformity of the operational instructions to the safety analysis report and to allow the control of this conformity.

Means should also enable the implication of the consignor in the transport process as soon as possible, including during the approval certificate require.

2. Training

Training has to be strengthened.

All operators (shippers, handlers and carriers, designers) should communicate about the tie-down of the packages.

3. Ergonomy of tools and documents

The consignors, in association with the authorities, should improve the ergonomy of the transport documents. Measured values and regulatory limits should appear directly on the documents.

Adapted tools should be developed to ensure the presence of protective plate or lid and the tightening of screws, to avoid the presence of unauthorized objects in the packaging and more generally, to limit human errors during the preparation of the packages.

4. Feedback from the use and the maintenance of the packages

The applicants should improve the follow-up of the modifications on the package design, particularly for the packages they have not designed or that they do not own, in order to be sure that they have all the information important for the safety of the package transport.

Communication about the feedback of the package maintenance and use between all stakeholders (applicant, shipper, package owner and competent authority) should be improved. This feedback should be examined for each certificate application.

5. Monitoring of the subcontractors

Sub-contractors have to be monitored in order to check that the services provided comply with the requirements. This monitoring could be commensurate. It should be documented and realized by competent and qualified people.

6. Radioprotection

In the medical sector, transport participants should take a common approach to optimize radiation protection of the operators at each step. In particular, the organization of the deliveries, the loading plans, the storage in transit and the transshipments should be included in this approach (for example, loading plans minimizing unloading operations at each delivery could be thought out).

Healthcare facilities should reinforce their organization in order to guarantee that their shipments respect the regulation. In particular, training should be improved and shipment procedures have to be completed.

Studies will be launched in order to assess the real doses received by the carriers. The results will be analyzed to define an action plan.

7. Emergency preparedness

Planning local emergency exercises should be fostered.

Because each deviation needs to be taken into account, ASN, IRSN and other organizations involved in transport are thinking about how to draw lessons from incidents and inspections. On behalf of ASN, several technical working groups will be created in order to improve safety and radiation protection. Guides will be published or updated to detail some regulatory requirements for specific actors (for example in the medical sector) or to explain what is expected concerning specific requirements (like emergency preparedness).

In parallel, ASN is thinking about developing a carrier registration system in order to improve its knowledge of the different stakeholders of the transport and extend its control.

The conclusions of this analysis will also be used to establish next ASN inspection program.

REFERENCES

Experience feedback on transport of radioactive material in France based on lessons learnt from ASN inspections and events between 2007 and 2011 : <http://www.french-nuclear-safety.fr/index.php/English-version/ASN-s-publications/Others-ASN-reports/Experience-feedback-on-transport-of-radioactive-material-in-France>

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