



## Experience feedback on transport of radioactive material in France



Based on lessons learnt  
from ASN inspections and events  
between 2007 and 2011

# EXPERIENCE FEEDBACK ON TRANSPORT OF RADIOACTIVE MATERIAL IN FRANCE

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between 2007 and 2011**



Meeting of the Advisory Committee of Experts for Transport and the Transport Safety  
Commission of 4<sup>th</sup> December 2012

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## **1. CONTEXT**

ASN (Autorité de Sûreté Nucléaire), the French nuclear safety authority, oversees the safety of transport of radioactive material for civil use in accordance with Articles L. 595-2 and L. 596-1 of the Environment Code. The sampling inspections performed by ASN during the manufacture or the shipment of packages are neither exhaustive nor systematic. On the basis of the information obtained during its inspections or when analysing experience feedback from notified events, ASN proposed to the members of the Advisory Committee for Transport and of the Transport Safety Commission, for information, to present them some of the experience feedback concerning the transport of radioactive material for civil uses in France, and to determine, as necessary, lines for improvement to enhance safety.

These elements are based on the ASN inspection reports and on the events notified by the consignors and carriers<sup>1</sup> between 2007 and 2011<sup>2</sup>. In all, more than 500 event notifications (significant events<sup>3</sup> and notable events<sup>4</sup>) relative to transport on public roads or within the perimeter of a basic nuclear installation (BNI) and more than 400 inspection reports have been examined. The events and inspections relating to Defence activities are not considered in this report.

This report is also based on comparisons with the foreign nuclear regulators' inspection practices and some general observations raised when assessing the approval applications to which IRSN (French Institute for Radiation Protection and Nuclear Safety) has drawn ASN's attention and illustrating the examples mentioned.

This report was presented to the Advisory Committees for Transport on 4th December 2012.

## **2. THE INSPECTIONS AND TRANSPORT EVENTS CONSIDERED**

### **2.1. Introduction**

ASN has been responsible for overseeing the safety of transport of nuclear material for civil purposes since 1997, and its action in this area comprises in particular:

- checking, from the safety aspect, all the stages in the life of a package, from design and manufacture through to maintenance;
- checking compliance with the safety regulations during shipment and transportation of the packages.

To fulfil this task, ASN has 43 specially trained and qualified inspectors, the majority of whom are sworn-in. More specifically there are:

- 14 inspectors divided among the ASN departments, including a team of 7 inspectors in the central department (Transport and Sources Department), which performs some inspections and is responsible for delivering the certificates of approval of the package designs or the certificates of approval for shipment;
- 29 inspectors<sup>5</sup> divided among the 11 ASN divisions, who are also qualified as nuclear safety and/or radiation protection inspectors and who devote about 10% of their working time to transport inspections.

All these inspectors are also responsible for processing and analyzing significant events, and they take part in the national emergency situation exercises.

These figures must be considered in relation to the number of packages of radioactive material transported in France (see appendix 1), estimated at some 900,000 packages per year according to a study carried out by IRSN in 2006. A survey is in progress to update these figures. The updated figures should be available late 2012.

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<sup>1</sup> In accordance with the ASN guide of 21<sup>st</sup> October 2005 on the conditions of notification of significant events [2].

<sup>2</sup> Certain events prior to or notified in 2012 are also mentioned in this report to illustrate particular points.

<sup>3</sup> Incidents or accidents of particular significance, particularly in terms of actual or potential consequences on the workers, the public, the patients or the environment, are called "significant events".

<sup>4</sup> Deviations that have no impact on transport safety. These events are not classified on the INES scale.

<sup>5</sup> Data drawn from the ASN annual report of 2011.

## 2.2. ASN inspections

### 2.2.1. The activities overseen by ASN

Each year, ASN draws up a forward-looking inspection programme. In addition to these scheduled inspections, a number of "reactive" inspections are carried out following events or if there is a specific need. These inspections may be carried out with or without prior notice. Each year, ASN carries out about one hundred inspections at the various stages in the life of a radioactive material package:

- during **package manufacture**: here, the inspectors check in particular the consistency between the package design safety analysis report assessed by IRSN, the manufacturing specifications and the various procedures. They also check the conditions of supplying and storage of material, the manufacturing procedures, the qualification of the personnel and the analysis and processing of manufacturing deviations. These inspections are carried out on the manufacturers' premises in France and abroad. With the manufacture of packages intended for use as **packages not subject to ASN approval** (industrial or type-A packages), the verification focuses on the content of the compliance report drawn up by the manufacturer and its consistency with the issued certificate of conformity;
- during **performance of the regulatory tests** (drop test or fire test): the inspectors verify the conformity of the test specimen, the compliance of the test conditions with those described in the test programme (which will be included in the package design safety report), the calibration of the measuring instruments used and the test results. These inspections are carried out both in France and abroad;
- during **maintenance**: the inspectors more particularly check compliance with the requirements of the safety analysis report, the list of deviations and their processing. The maintenance manual is examined in the light of the information provided in the approval certificate and the safety analysis report. These inspections are carried out in France in basic nuclear installations (BNIs) and other non-nuclear facilities.
- during **shipment, carriage or reception of packages**: the inspectors check compliance with the applicable modal regulatory requirements and examine the general way in which the companies organise their transport activity and their specific organisational measures to respond to incident or accident situations. They verify that the packages are used in accordance with the safety analysis report and the user's manual. These inspections are carried out in a wide variety of places: basic nuclear installations, laboratories, industrial radiography companies, health centres, transit facilities, etc.

Each inspection gives rise to a follow-up letter posted on the ASN web site: [www.asn.fr](http://www.asn.fr).

ASN also conducts inspections concerning **safety management** with the major operators in radioactive material transport to assess the interfaces between the different stages of transport operations. Thus, in 2012, three technical inspections were carried out with the Logistics Business Unit of AREVA, of the CEA and of EDF, in order to analyse their organisation, their procedures and the means implemented for the transport of radioactive material.

Inspections were also organised with transport inspectors responsible from the control of the transport of other dangerous goods<sup>6</sup> and customs officers. These joint inspections are intended to check the conditions of carriage of the packages (driver authorisation, vehicle placarding, presence of the on-vehicle safety kit, etc.) and can be carried out at the exit of certain BNIs or on major roads.

The breakdown of ASN transport inspections is illustrated in figure 1.

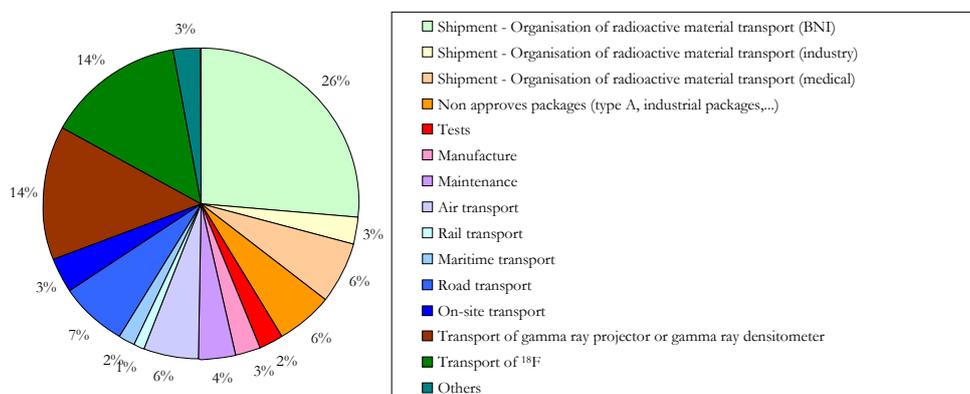


Figure 1 : Distribution of ASN inspections from 2009 to 2011

<sup>6</sup> inspectors from the DREAL (Regional Directorate for the Environment, Planning and Housing)

This breakdown can vary from one year to the next depending on the priority inspection themes defined for the year on the national scale. For example, priority inspection themes have included gamma ray projector transport in 2001, 2004 and 2005; the conformity of packages not subject to approval in 2003, 2005, 2006, 2011 and 2012; examination of the work of the safety advisors in 2002 and 2007; maintenance of packages in 2004 and 2011, and the radiological protection programmes in 2003 and 2004.

These priority themes are established on the basis of event notifications, ASN inspections concerning the transport of radioactive material or other areas (safety, radiation protection, etc.), and any changes in the regulations.

*During a bilateral meeting, AFCN, the competent Belgian authority, gave ASN a presentation of the system implemented in Belgium to develop its annual inspection programme concerning the transport of radioactive material. Belgium has a system for registering carriers which means that the inspectors have an exhaustive list of all the carriers. The Belgian inspection programme for nuclear transport is determined from this database, adopting a graded approach based on the type of material transported (nuclear material), the quantity and type of package transported, the nature and extent of transport operations, any previous incidents, and the findings of previous inspections, etc. The inspectors give each company a number of points for each parameter. The sum of the points is used to determine the frequency at which the company must be inspected. A "major carrier" can thus be inspected up to 3 times per year, whereas a smaller company, already known from previous inspections, may be inspected just once every 5 years.*

ASN is confronted with difficulties in identifying the transport companies, as there is no system for registering carriers in France. This difficulty could be overcome if the draft European regulation were adopted (see paragraph 2.4 herein).

### 2.3. Notified events

#### 2.3.1. Number of events notified

The notification of events relative to the transport of radioactive material is a regulatory requirement (for land transport, Article 7.4 of the TMD[1] order<sup>7</sup>. The package consignor is responsible for notifying events, as provided for in the ASN guide to events notification **Erreur ! Source du renvoi introuvable.** This being said, it is also the duty of the other stakeholders (carriers, handlers, consignees, etc.) to inform ASN and the consigners.

The following graph shows the variations in the number of significant events notified since 2001.

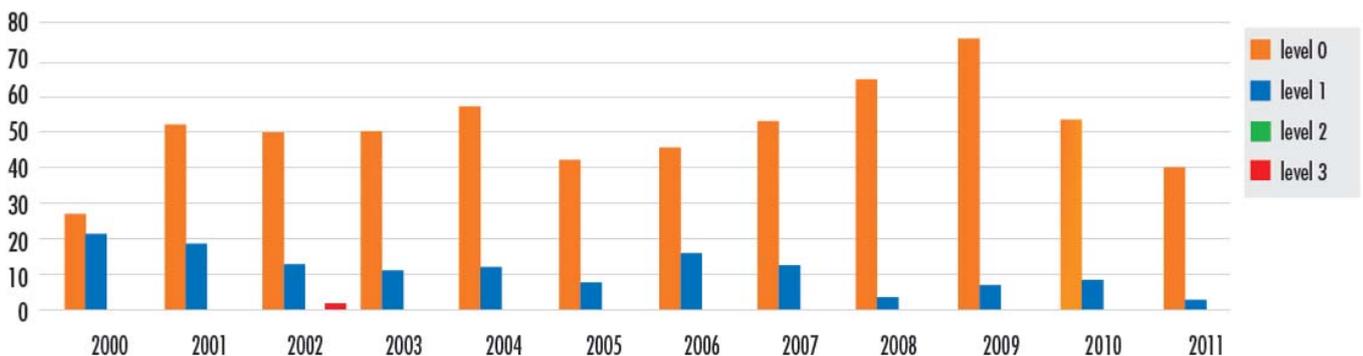


Figure 2 : Trend for the number of significant events concerning the transport of radioactive material notified between 2000 and 2011.

<sup>7</sup> For air transport, the written notification must be addressed to ASN and the DGAC within 72 hours (divergence FR 9 of the ICAO Technical Instructions, 2011-2012 Issue). For maritime transport, the notification is required by paragraph 1.5.6 of the IMDG Code, and provision 715 of paragraph 4 of the RPM order.

In addition to these significant events classified on the INES (International Nuclear Events Scale) scale, one must consider the notable events notified to ASN, the number of which are shown in the following graph:

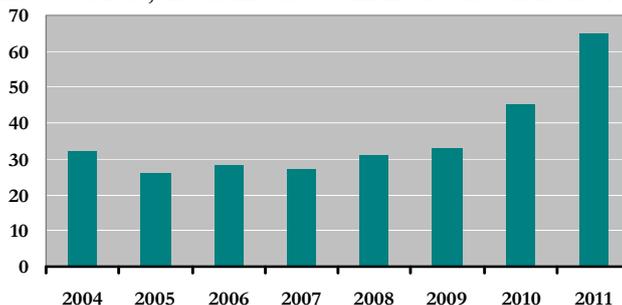


Figure 3 : Trend for the number of notable events concerning the transport of radioactive material notified between 2000 and 2011.

After an initial increase, the number of events notified has stabilised over the last few years. Nevertheless, since 2010 there has been a drop in the number of "significant events" and a rise in the number of "notable events", which can be explained essentially by better detection of the "early warning signs" or deviations that have no impact on transport safety, and by a change in the recording of events involving impacts on radiopharmaceutical packages in airports. To facilitate incident analysis, the corresponding notification criterion has been adjusted so that only impacts that could affect the safety of the package are taken into account. Minor impacts of no real consequence are now recorded as "notable events".

More generally, ASN finds that knowledge of event notification conditions has improved, particularly in small-scale nuclear activities<sup>8</sup>. The importance of events notification is a subject which, since events notification was made mandatory, ASN regularly places on the agenda during awareness-raising campaigns (seminars, information days, etc.) addressing radioactive material transport protagonists.

ASN has recorded no radioactive material transport incidents of level 2 or higher on the INES scale since 2000, apart from one incident that occurred during a shipment by air that resulted in several people being irradiated (see section 6.1 and the incident notice in appendix 2 of this report).

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<sup>8</sup> Small-scale nuclear activities: nuclear operators, excluding Basic Nuclear Installations (BNIs), using ionising radiation and including medicine (radiology, radiotherapy, nuclear medicine), human biology, research, industry, certain veterinary and forensic medicine applications, and the preservation of foodstuffs.

### 2.3.2. Event categories

Transport events can be classified in 20 main categories as shown in the figure below:

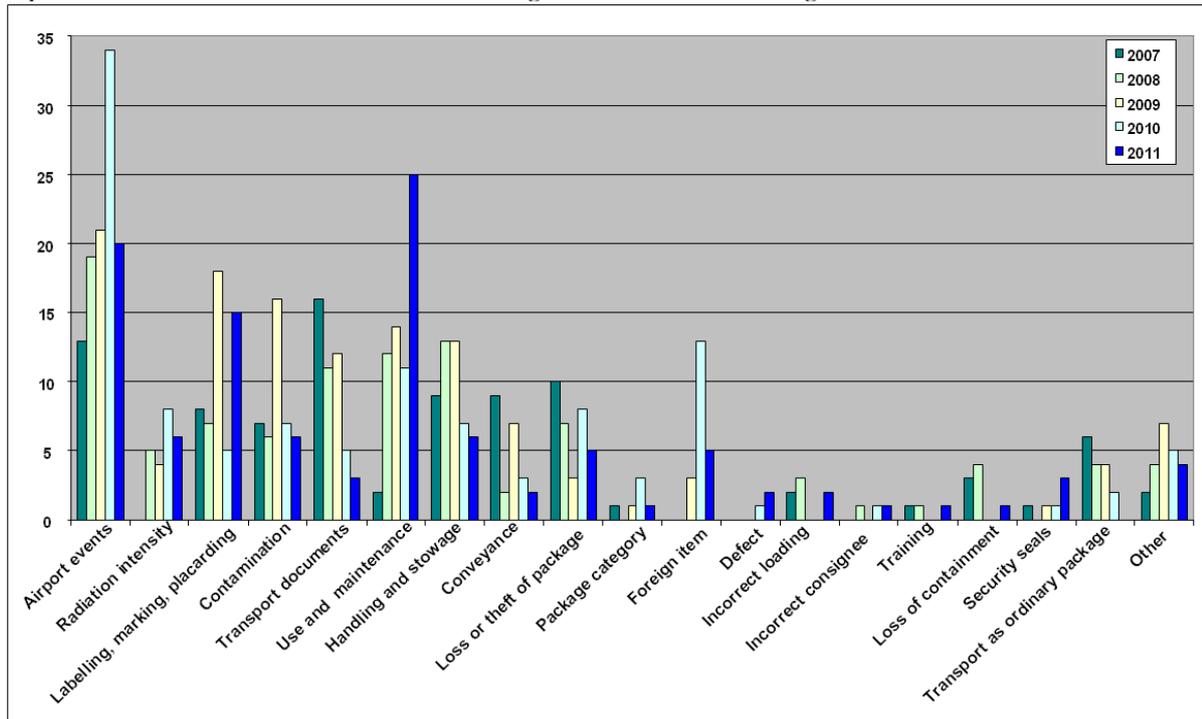


Figure 4 : Distribution of events notified between 2007 and 2011 by cause and by year\* (significant events and notable events)

\*The elements entering into each event category are described in the table on the following page.

Figure 5 shows that the last few years have seen an increase in event notifications relating to noncompliance with utilisation or maintenance procedures, or deviations from the certificate of approval or conformity (deviations illustrated in figures 4 and 5 by the "Utilisation and maintenance" category). These deviations are covered in sections 3.2 and 7.3.1 of this report.

A slight reduction in notifications relating to lack of stowage of the packages (airports excluded) is also observed. This point is covered in section 4.4.

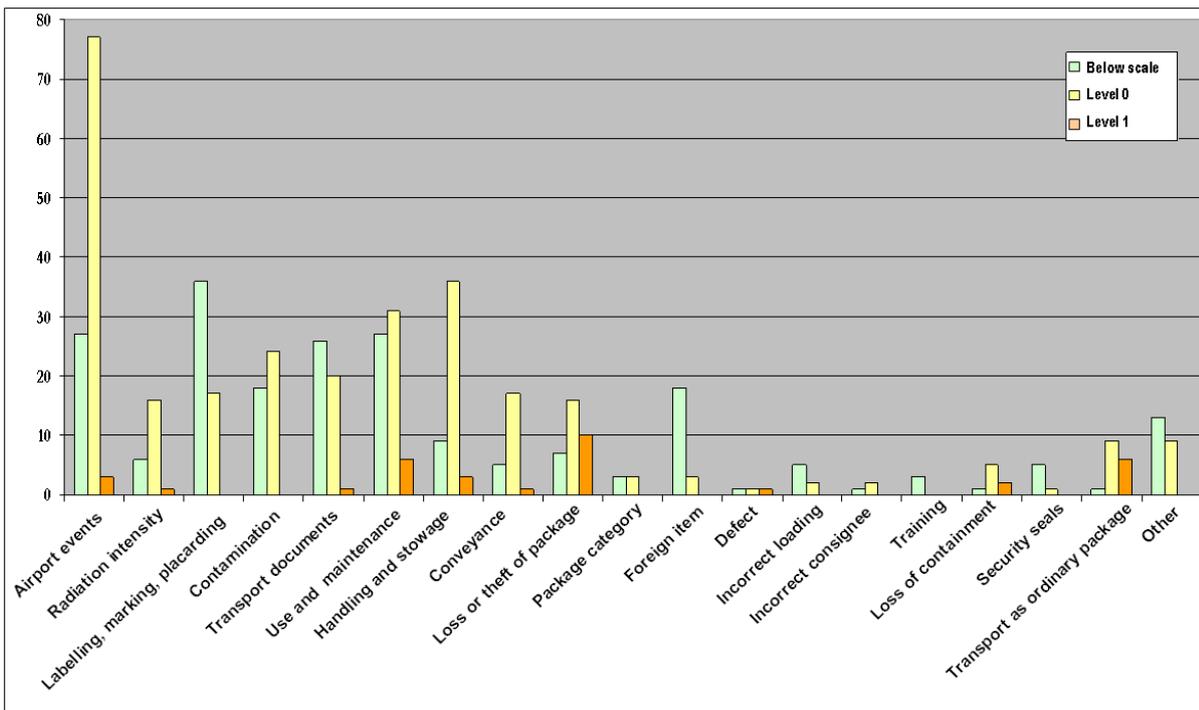


Figure 5 : Distribution of events notified between 2007 and 2011 by cause and by level on the INES scale

The events categories considered for the development of figures 4 and 5 are detailed in the following table:

Category	Details
Airport events	Damage to packages during air transport (fall, impact, wetting, excessively-tight stowage, damage by fork-lift truck forks, etc.) or deviation with respect to an airline's procedure
Radiation intensity	Difference between the radiation intensity measurements made by the consignor and consignee, or exceeding of the limit applicable to the type of package
Labelling, marking, placarding	Deviation in the labelling, marking or placarding
Contamination	Difference between the contamination measurements made by the consignor and consignee, or exceeding of the limit applicable to the type of package
Transport documents	Deviations in the filling out of the transport documents or absence of the documents required by the ADR regulations
Use and maintenance	Deviations from the requirements of the user's or maintenance manual or of the certificate of approval (or conformity) of the package design
Handling and stowage	Deviations relating to incorrect tie down or securing during handling
Conveyance /Carriage	Deviations relating to road and rail accidents, and problems concerning the conveyance (engine fire, failure, etc.)
Loss or theft of package	Loss of package (whether package is found or not) Notifications of theft or broken seals
Package category	Error in the classification of the material or concerning the chosen type of package
Foreign item	Presence of foreign items in the cavity of the packages
Defect	Defect in the manufacture of the package
Loading error	Difference between the loading and the packing list or the transport document
Incorrect consignee	Package delivered to the wrong consignee or delivery of an activity higher than the consignee is authorised to receive
Training	Deviation concerning personnel training
Loss of containment	Loss of package containment (mainly packages of natural uranium)
Security seals	Omission of a security seal or switching of seal numbers
Transport operation outside class 7	Radioactive material or objects shipped in conventional packages (e.g. smoke detectors, contaminated lift (elevator) buttons, etc.)
Other	Miscellaneous deviations: discovery of empty packages, loading left without surveillance, presence of passengers

Note: The criteria and conditions of events notification are the subject of ongoing studies at ASN. This concerns all types of events: transport, safety, radiation protection, etc. The new criteria should be more precise and better adapted to the deviations or events observed. New notification criteria have also been created for events that have been recurrently observed in recent years and which ASN wishes to monitor with particular attention. Criteria that are adapted to on-site transport operations shall also be created. These criteria will be presented to the members of the Advisory Committee for Transport at a future meeting.

➤ *ASN has started revising the criteria and conditions of events notification. These criteria will be presented to the members of the various Advisory Committees of Experts at a future meeting as soon as the project is consolidated.*

The event notifications concern all types of package content and all modes of transport (see figure below).

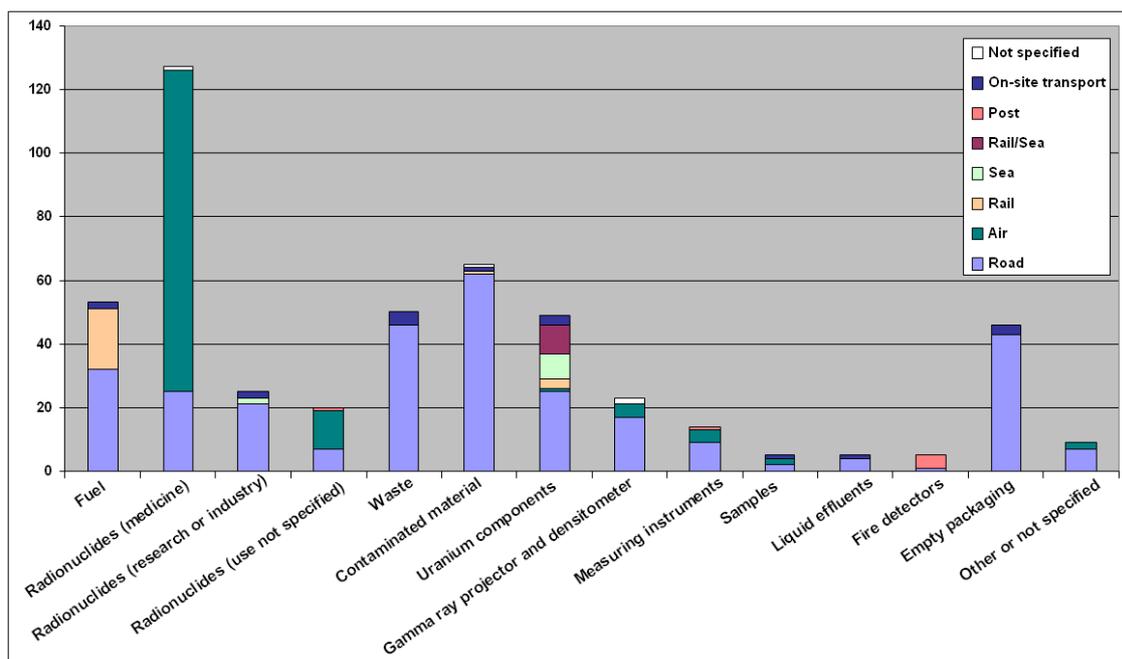


Figure 6 : Distribution of the number of events notified between 2007 and 2011 per type of content

About half the events are notified by the industrial operators in the nuclear cycle (EDF and AREVA in particular). About 16% of the events concern the radioactive pharmaceutical products shipped by CIS BIO IBA.

Very few transport-related event notifications are made by the conventional industry and research sectors. Analysis of the statistics nevertheless shows that this low notification level is probably due to small-scale nuclear activity professionals failing to notify events, usually due to a lack of knowledge of the events notification process.

The package contents concerned by the events notifications are extremely varied: radionuclides for medical uses, contaminated material, fuel, empty packages, etc.

#### 2.4. The French stakeholders of the transport of radioactive material

Carriers of radioactive material shall respect the dangerous goods regulations, but in France they are at present not subject to a registration system unless transporting nuclear material, unlike several other European countries. Consequently there is no exhaustive list of French carriers.

Article R. 1333-44-I of the Public Health Code states that: *"without prejudice to the regulations concerning the transport of hazardous goods, companies transporting radioactive material are subject, for carriage on French territory, to giving notification to or obtaining authorisation from ASN. An ASN resolution approved by the Ministers for Nuclear Safety and Transport specifies the characteristics of the radioactive material that require either authorisation or notification, the composition of the authorisation application file and the elements to be enclosed with the notification, the conditions of examination and the conditions of renewal, withdrawal and suspension."*

In 2008 ASN had initiated a draft resolution relative to the notification and the authorisation of radioactive material transport companies, such as provided for by the Public Health Code. This draft resolution was suspended on the announcement of a draft European regulation planning to establish a community-wide system for registering radioactive material carriers and replacing the various national notification and authorisation systems.

The stated aim of the proposed regulation presented by the European Commission is to:

- replace the various national notification and authorisation systems for radioactive material carriers introduced by Council directive 96/29/Euratom of 13<sup>th</sup> May 1996, by a single registration system centralized at European level via a web interface;
- help remove the hindrances to the domestic market for the transport of radioactive material while at the same time guaranteeing public safety and health protection during the transport of radioactive material;
- enhance transparency in the legislation covering radioactive material transport operations;
- establish national points of contact to direct the carriers towards the competent authorities and the relevant information.

These draft regulations could therefore make it possible to:

- meet the radiation protection objectives provided for by directive 96/29;
- heighten carrier awareness of the provisions of the regulations and the risks that radioactive material represent (see paragraph 6.4.4);
- obtain an exhaustive list of the European carriers of radioactive material, which would facilitate their oversight through ASN inspections;
- have administrative penalties if breaches of the regulations are observed (suspension of the registration certificate necessary to exercise the activity).

At present, some member States are strongly opposed to the proposed regulations presented by the Commission, and ASN expresses strong reservations on the applicability of the regulations in the very short term, particularly with regard to the implementation of a tried, tested and robust European computerised system. Consequently, ASN is considering reviving the ASN draft resolution, anticipating insofar as possible the transition to the future European computerised system for registering carriers.

### **3. THE PREPARATION OF PACKAGES**

#### **3.1. Area considered**

This chapter will focus on the preparation of the packages: choice of packaging (material-packaging compatibility), verification of content conformity, loading of the content, verification of the packaging before closure if required by the safety analysis report or the package design certificate (for example, inspection of the seal grooves or checking operation of the closing system) and other steps through to closure of the packaging and performance of the leak-tightness tests.

#### **3.2. Noncompliance with the certificates of conformity or approval**

Several deviations in conformity with the packaging certificate have been notified or detected during package preparation inspections. These deviations are of a regulatory nature and could affect the safety of the package. ASN considers that no deviations of this type, whatever their implications for safety, must be trivialised. The persons responsible for transport operations must remain in control of all the safety requirements relating to transport. On this account, the consignor assumes responsibility for the conformity of the consignment with the regulations.

##### **3.2.1. Deviation relative to the content specified in the certificate**

To give examples, ASN has detected:

- **Example 1 insufficient drying** during packaging maintenance, resulting in the **presence of water in the packaging**. The water was detected during package preparation before filling the packaging, which was intended to contain fuel. Ensuring the absence of water in fuel packaging is an important factor in demonstrating safety relative to the criticality risk and the absence of production of hydrogenated gas by radiolysis<sup>9</sup>.
- **Example 2: the presence of oil (liquid)** in an industrial package, thereby failing to comply with the definition of the content which only authorised solid contaminated objects. This deviation had no consequences, but the presence of liquid or water could lead to dissemination of the contamination of the transported objects or corrosion of the equipment and the container.
- **Examples 3 and 4: the presence of polyethylene straps** gathering fresh fuel elements in a package and the **presence of vinyl bags** surrounding UO<sub>2</sub> powder in a second package, while the certificates of the two package designs in question specified that "the presence of covers made from material more hydrogenated than water is prohibited". Such deviations could have jeopardised the safety of the package (criticality risk or production of hydrogen).

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<sup>9</sup> I.e. by breakdown under the effect of the radiation

- **Example 5: Foreign items** (seals, screws, rags or other) are sometimes found in the bottom of fuel packagings when performing maintenance. The presence of hydrogenated foreign items in the packagings could lead to an increase in the internal pressure if they were to undergo radiolysis, or even induce risks of explosion through the production of inflammable gases. ASN is therefore particularly attentive to this issue, and has asked the operators concerned (AREVA NC, TN International, EDF and MELOX) to propose an action plan (see appendix 1 for further details).

Over and beyond simple human errors and a lack of rigour, ASN identifies the following problems as potential causes of these deviations:

- a lack of communication between the various transport operators, especially the consignor and the applicant when preparing the approval application:
  - the applicant is not familiar with the practices of the consignor: for example, the applicant does not know that covers are placed around the primary container, and therefore does not take them into consideration in the safety analysis report,
  - the consignor does not take part in the reviewing of the draft certificate or is not aware of those provisions of the approval certificate that are important for safety, and does not realise that it is not complying with the provisions of the certificate.
- deviations when establishing the shipment procedure and/or failure to verify conformity with the safety analysis report and the certificate,
- insufficient information in the user's manual concerning the requirements relating to the authorised content;
- poor ergonomics of the approval certificate<sup>10</sup>: the various verifications required during package preparation and shipment are divided into several different paragraphs on the certificate and sometimes refer to chapters of the safety analysis report (in which case the certificate is not self-supporting).

⇒ *The consignor must be included in the transport process as early as possible, i.e. from the approval application stage.*

⇒ *The necessary organisational and human resources must be put in place to ensure verification of the safety analysis report and its correct application in the operating procedures.*

⇒ *The applicants and the authority could undertake a reflection on the ergonomics of the approval certificate.*

### 3.2.2. Deviation relative to the packaging description specified in the certificate

The deviations with respect to the certificate can also concern the packaging. By way of example, ASN has noted:

- **Example 1** in 2008: The silicone seals used on some of type-B package for fissile material of a same design did not meet the requirements of the package design approval certificate;
- **Example 2: omission of caps or plugs** on the packagings:
  - omission of the cover of a self-sealing coupling of a package intended for transporting plutonium powder. This deviation was not detected during the leak-tightness test,
  - omission of a fusible plug on a packaging intended for transporting technological waste, after performing the leak-tightness test,
  - omission of an orifice plug on an empty packaging intended for transporting fresh MOX fuel,
  - omission of two caps on a packaging used for on-site transport.

These events were generally detected by the consignee when the packaging was opened after transport. In the majority of the cases described, the pre-departure check-lists were filled out exhaustively and did not enable the these omissions to be identified.

Some licensees have provided operators with special tools to prevent such omissions, for example a tool that can only be separated from the cap once the cap is in the locked position on the packaging.

- **Example 3: non-tightened screws** on spent fuel packaging :

In the past, consigners of spent fuel packages have notified events concerning deficiencies in the tightening of the screws on the package shock absorbers. Given the repeated nature of these events, additional utilisation

<sup>10</sup> The package design approval certificate is delivered by ASN on the basis of a draft certificate submitted by the applicant with the approval request. The structure of this certificate is defined in the applicant's guide (see paragraph 8.1).

instructions were applied, such as specifying a waiting time for the package to reach thermal equilibrium before final tightening, and having the tightening torque of each screw double-checked by two different operators, each with their own torque wrench.

In spite of these measures, several further events relating to screw tightness deficiencies were notified in 2011 (screws on spent fuel packages shock absorbers that could be unscrewed by hand on arrival at the La Hague site). In view of its repeated nature, ASN has rated this deviation level 0 on the INES scale and demanded that TN International and EDF put in place a tightened surveillance plan for the spent fuel packagings and draw up an action plan from this.

In 2012 a working group with representatives from EDF, TN International and Areva NC La Hague was created to analyse the potential causes of this screw tightening problem. This working group also plans to carry out cross-visits between Areva NC La Hague and the EDF NPPs in order to compare practices. TN International informed ASN in April 2012 that it had detected insufficiently clear screw greasing instructions in the safety analysis reports of several package designs. TN International supposes that the lack of grease under the screw heads is a possible cause of the tightening defects in the shock absorber screws. The user's manuals have been updated accordingly.

EDF for its part will inform ASN of the results of its surveillance programme and the conclusions of the working group will be made known to ASN, IRSN and the applicants.

Note: The chapter 6A of the safety analysis reports (concerning the use instructions of the package) examined by ASN with the technical support of IRSN in the approval applications sometimes specifies a criss-cross tightening sequence for the screws. As there can be 8 screws per shock absorber, 30 for the cavity closing system (example of the TN 13/2 package), such a procedure can induce errors. Appropriate operating procedures and tools must be put in place to prevent the risk of human error (numbering of screws, marking or other procedure or tool considered useful).

➡ *Implementation of appropriate tools for ensuring the presence of plugs or caps, tightening of the screws, limiting the possibility of objects falling into the packagings and, more generally, limiting the risks of human error during package preparation, are to be encouraged.*

### 3.2.3. Deviation relative to the provisions of the packaging user's manual

When the ASN inspectors consult the packaging shipment files, they usually ask to be given the chapter of the safety analysis report relative to the use of the package model, or proof of the conformity of the user's manual with this chapter of the safety analysis report. This is because the package design approval certificates (or the certificates of conformity for the package designs not subject to approval by the competent authority) provide for the package to be used in accordance with the chapter of the package design safety analysis report that relates to utilisation of the packaging. The consignor must therefore have this chapter in order to check compliance with the certificate. Failing this, the consignor can also refer to a user's manual whose conformity with the safety analysis report has been verified.

Several consignors have indicated that when performing inspections, **they have not had access to the chapter of the safety analysis report relative to the utilisation of the package design and have not been able to prove that the utilisation procedure they applied was compliant with the safety analysis report.** ASN has observed this for various package designs (type-B packages and packages not subject to approval) with consignors from different groups and organisations. This has also been observed with entities belonging to the same group as the applicant (or issuer of the certificate), under conditions of transport on the public roads or during on-site transport operations.

ASN considers that this situation can jeopardise safety. The transfer of information from the safety analysis report into the utilisation procedures has been regularly verified during inspections. Since 2012, each time an approval certificate is issued, ASN asks to be communicated "the measures taken to inform customers or partners - whether concerned directly or indirectly by the use or maintenance of the packagings - of the safety factors presented in the safety analysis report chapters referenced in the issued certificate, and of their updating".

Deviations involving noncompliance with the user's manual of a package have also been observed:

- In 2007, a type-B package for transporting radioactive sources fell from a height of 1.20 m during unloading from a lorry using a forklift truck. Package sealing was preserved and the event had no consequences on the personnel. Analysis of the event showed that the package approval certificate specified unloading in the

facility using lifting eyes provided on the package (handling with a forklift truck was not authorised). This requirement was not specified in an operating procedure. There was no user's manual for the packaging.

- In 2012 ASN was informed of a deviation between the tool used and that planned for in the user's manual and the safety analysis report of a spent fuel package design. This deviation involved an error in the volume of the tool used to check the leaktightness of the orifices providing access to the inter-shell space. The volume of the tool used was greater than that specified in the user's manual, meaning that the maximum leakage rate of these orifices specified in the safety analysis report could no longer be guaranteed. According to the first information from the applicant, the packaging utilisation tests supposedly led to this volume being changed, without this change being carried over into the packaging user's manual. This event is currently being analysed.

The transfer of information from the safety analysis report must be verified at all stages of the transport process (see line for improvement No.1).

### 3.3. Improving training.

The regulations applicable to the transport of radioactive material specify that<sup>11</sup>: “*Individuals such as those who classify radioactive material; pack radioactive material; mark and label radioactive material; prepare transport documents for radioactive material; offer or accept radioactive material for transport; carry or handle radioactive material in transport; mark or placard or load or unload packages of radioactive material into or from transport vehicles, bulk packagings or freight containers; or are otherwise directly involved in the transport of radioactive material as determined by the competent authority; shall receive the following training*”. For each person, this training must include specific training “*which is applicable to the function that person performs*”.

The inspectors observe that the quality and scope of the training courses organised by the various transport stakeholders is very varied and sometimes insufficient.

Some companies have nevertheless set up an operator training programme aiming to explain the different requirements of the operations in the safety analysis report or the packaging user's manual. These practices could heighten operator awareness of the verifications to be performed and perhaps reduce the deviations that arise in package preparation.

These practices could be useful at each stage in the transport of a package, from its preparation and shipment to transport and reception. Similarly, they should not be limited to the area of BNIs, but must be extended to small-scale nuclear activities.

⇒ ***Operator training must be reinforced.***

⇒ ***The ergonomics of the training media could warrant reviewing.***

⇒ ***If outside contractors are used, the training must be verified by the ordering customer.***

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<sup>11</sup> Paragraph 313 of IAEA document TS-R-1.

## 4. THE ORGANISATION AND SHIPMENTS OF PACKAGES IN BASIC NUCLEAR INSTALLATIONS (BNI)

### 4.1. Integrating organisational and human factors (OHF)

#### 4.1.1. Notified events

ASN has been notified of several events involving operators mixing up packages during shipment. For example:

- In 2008, confusion between two primary containers which led to the on-site transport (i.e. within the same site) of a material whose burn-up fraction exceeded that authorised by the certificate.
- In 2012, at the Valognes terminal where several tank containers of uranyl nitrate were located, tank No. 65 was hitched to the trailer and transported instead of tank No. 18. Transportation was therefore carried out with the transport documents of the wrong tank.
- In 2011, mixing up of a fresh fuel trailer and an empty trailer departing from an NPP. The reactive inspection subsequent to the incident resulting from the accidental switching over of the trailers revealed a succession of organisational shortcomings that led to deviations from the radioactive material transport regulations: noncompliance with procedures, inappropriate quality documents relating to reception and shipment, trailer parking conditions requiring improvements, lack of refresher training (see incident notice in appendix 2),

These events also concern regulatory deviations corresponding to packages shipped although levels exceeding regulatory limits had been measured. In 2011 for example, a consignment of spent fuel was shipped although its dose rate at a distance of 2 metres from the surface of the vehicle exceeded the regulatory level. The first part of the transport operation was carried out by road to reach the railway network junction situated several kilometres from the nuclear power plant. The checks performed prior to train departure revealed a radiation intensity at one measuring point of 0.13 mSv/h at 2 metres from the wagon (instead of 0.1 mSv/h). The licensee's investigations revealed that the checks performed on departure from the site had indeed detected this dose rate exceeding the regulatory criterion, but the exceedance had not been picked up by the person in charge of shipment. ASN conducted a reactive inspection to analyse the circumstances of this event. ASN asked the licensee to perform a detailed analysis of the organisational and human factors underlying this event and to take measures to ensure that it could not happen again. The inspectors noted that the maximum radiation intensity value measured was recorded in the transport file, but that the measurement details (points of measurement, measured values) had not been conserved.

This inspection also enabled to underline the size of the shipment files, which comprise several tens or even hundreds of pages, and this does not necessarily facilitate highlighting of the important information or the deviations.

➡ *The consignors should improve the ergonomics of the radioactive material transport documents, notably by showing directly on the transport document the measured values and the associated regulatory values or criteria.*

➡ *The integration of organisational and human factors at each stage of the transport process is to be reinforced. Particular attention must be paid to shipments of radioactive material.*

#### 4.1.2. ASN technical visits on the theme of organisational and human factors

Further to the findings of the inspectors and the increase in event notifications indicating "human errors", in 2012 ASN organised three technical visits to the main operators in the transport of radioactive material for the fuel cycle, namely AREVA, EDF and the CEA. ASN called upon experts in organisational and human factors from INERIS (French National Institute for the Study of Industrial Environments and Risks) to assist it on these visits.

The aim of these visits was to review the integration of organisational and human factors in the different stages of transport and to focus in particular on:

- the responsibilities and interfaces between the different entities involved (designer, manufacturer, consignor, carrier and entity responsible for packaging maintenance);
- the interfaces with any subcontractors, and the monitoring actions;
- the process for carrying over the requirements of the safety analysis report and the regulatory requirements at all stages of the transport operation;
- taking account of lessons learned and feeding back information in the event of detection of a nonconformity or an incident, or in case of difficulty.

The degree of depth to which these themes were taken was adapted according to the specifics of each of the three entities and their activities.

For each entity the technical visits lasted three consecutive days: two days in the central services and one day at the shipment unit. The chosen methodology consisted in:

- holding interviews with the various people involved in radioactive material transport during the three days of visits;
- analysing the documents handed over prior to or during the visit (quality assurance manual, processes, events analyses, etc.)

The visits took place in the third quarter of 2012, and the final conclusions will not be available until the end of 2012. Work is still required to cross-check the interviews, analyse the documents and stand back to view the situation. The conclusions will be discussed with the participants before they are formalised.

#### 4.2. Sharing experience feedback

In 2011 ASN was informed of an event relating to the failures of the closing device of an overpack for transporting uranium hexafluoride (UF<sub>6</sub>) cylinders. This American-designed overpack consists of two half-shells joined by means of 10 ball-lock pins (see photos in appendix 2) and two arch-shaped closing bands.

The incident involved the disengagement of some of the ball-lock pins during transport due to their untimely release. The additional mechanism comprising the two arch-shaped bands for closing the two half-shells guarantees that there is no risk of the overpack opening during normal use of the transport package. However, in the event of a transport accident, the mechanical resistance of the overpack would be reduced.

Disengagement of some ball-lock pins was observed three times in 2010 and 2011 by several entities within the same company. ASN instructed this company by letter to conduct in-depth investigations into the reasons for the failings observed on the overpacks. An inspection was moreover carried out on the premises of two overpack consignors from that company to verify the corrective measures implemented.

During these inspections, ASN noted that the experience feedback from this event had not been taken into account in the same way by the two consignors and that the proposed corrective measures were not implemented with the same stringency, evidencing insufficient sharing of this experience feedback.

Examination of the event revealed that the American designer of the overpack design had recommended, before the events occurred in France, the replacement of the current pins by pins of a different design that should improve their locking. This experience feedback from the USA had not been made known to the French users: the corresponding design modification had only been carried over to the restricted part of the safety analysis report (private version of the safety analysis report) for questions of industrial secrecy and had not been re-transcribed in user manuals sent to all users, including the French users.

All the overpacks belonging to French companies are currently undergoing pin replacement to integrate the American designer's recommendation, and the experience feedback from this event has been discussed within the EACA (European Association of Competent Authorities on the transport of radioactive material) and with the American authorities.

This event, the actual consequences of which were limited, shows that progress must still be made in the setting up of international experience feedback on the use of transport packages and on cooperation between the entities responsible for transport.

➤ ***Communication and sharing of experience feedback concerning the use and maintenance of packagings must be improved between all the protagonists (applicant, consignor, packaging owner and competent authorities)***

➤ ***The applicants must improve their tracking of the changes in the package design definitions, particularly when they are not the designers or owners of the packagings, in order to ensure that they have all the information liable to have an impact on the safety of transport of the package.***

### 4.3. Defining responsibilities

#### 4.3.1. Consideration of subcontracting

Licensees call upon subcontractors at different stages in the transport of radioactive material:

- for package manufacture (e.g.: manufacture of the UF<sub>6</sub> cylinders abroad, subcontracting of part of the manufacture of spent fuel packagings to other companies);
- for package preparation and the organisation of shipments (e.g.: subcontracting of shipments in certain NPPs);
- for carriage (e.g.: airlines subcontracting the freight and carriage to the aircraft to airport ground handling agents);
- for packaging maintenance (e.g.: some packaging owners subcontract packaging maintenance to the packaging manufacturer).

As a general rule, ASN finds that the second-tier inspection seems to lack rigour. Although the appropriation of the work of outside contractors by the ordering customers is improving, it does not seem to be sufficient. The inspectors have thus detected:

- insufficient consideration of feedback on satisfaction with outside contractors' work in the calls for proposals process;
- the lack of a defined target frequency for outside contractor monitoring actions and insufficient measures to monitor the service providers responsible for package shipment.

**⇒ Any transport operator must reinforce the monitoring of its subcontractors in order to ensure that the operations they perform, or that the goods or services they supply, comply with the specified requirements; This monitoring can be proportionate to the safety significance of the activities carried out. It must be documented and exercised by persons with the necessary skills and qualifications.**

#### 4.3.2. Sharing of responsibilities within a given group

Notifying ASN of events concerning the transport of radioactive material is the responsibility of the package consignors. The other transport operators (carriers, forwarding agents, consignees, etc.) have a duty to inform.

ASN was notified of a series of three events concerning a failure on an overpack for transporting UF<sub>6</sub> cylinders (see paragraph 4.2). The first notification was sent by the consignor company. The following two were sent by the transport organiser, a member of the same group as the consignor.

ASN also received an event notification from the same transport organiser relating to a deviation from the maintenance manual concerning several overpacks. Overpacks belonging to the transport organiser and to another consignor entity in the group were concerned.

These different event notification procedures could reflect a lack of clarity in the defining of roles and responsibilities within the various entities of the group, therefore ASN instructed the group concerned, by letter:

- to very clearly identify the distribution, among its different entities, of the regulatory responsibilities (shipment, transport, etc.), the mutual obligations in the case of internal contracting, especially with regard to maintenance;
- to ensure that the significant events are notified by the entity responsible for the event, by providing for coordination at group level.

### 4.4. Stowage of packages

The conditions of stowage of packages in or on the vehicles is something that ASN has been monitoring particularly closely in the last few years. ASN observes that several consigners and carriers or forwarding agents have improved their practices in this area. A specific review of package stowage has been integrated in the personnel training dispensed by some consigners and carriers. One pharmaceutical package transport organiser has thus communicated securing instructions to all the carriers with whom it works.

Nevertheless, the ASN inspectors still observe too many deviations in their various inspections, whether for consignments leaving BNIs or in small-scale nuclear activities, and essentially concerning packages not subject to approval. For example:

- in the shipment of concrete shells containing waste, ASN inspectors found that the stowage of the shells did not comply with the carrier's safety instruction manual which prescribed double-lashing with two sets of straps per shell;
- gamma ray projector collimators are not always secured in the vehicle; or the overpack of gamma ray is not always correctly tied-down (straps not tensioned);
- radiopharmaceutical packages are not always suitably secured (stowage that prevents movement of the package in one direction only).

About 8% of the events notified between 2007 and 2011 concern stowage deficiencies.

As a general rule, even though the situation has improved, one still observes insufficient application of the stowage instructions when loading packages, or failure to verify consistency between the stowage instructions of the packaging supplier and of the consignor, when several procedures exist.

⇒ ***The stowage of packages must be integrated in the training programme dispensed to the various operators in radioactive material transport***

#### 4.5. Pre-shipment measures

##### 4.5.1. Checking the dose rate

ASN has been informed of several events relating to deviations between the radiation intensity measured before shipment and that measured on reception of the packages. Some of these deviations have led to exceeding of the regulatory limits (in the case of excepted packages).

When these deviations are small, several hypotheses can be postulated to explain them: lack of rigour in performing the checks on the 6 sides of the packages, use of inappropriate or non-calibrated measuring instruments, insufficient blocking of the content of the package, resulting in it changing position during transport and increasing radiation intensity. These deviations must be analysed with caution because they could sometimes also be explained by the use of different instruments and by the measurement uncertainty of the instruments.

##### 4.5.2. Verification of package contamination

In spring 1998, a large number of cases of higher-than-normal contamination were discovered on packages and wagons transporting spent fuel from nuclear power plants and intended for the La Hague reprocessing plant. It is estimated that in 1997, 25% of the convoys from the NPPs displayed contamination beyond the regulatory limits at one point at least of the package or wagon. These contamination points were usually on surfaces inaccessible to the public, inside the canopy. The percentage of convoys contaminated on accessible areas is estimated at 5%.

These exceedances led to the suspension of the transportation of spent fuel by rail in May 1998, pending information on the radiological impact of convoy contamination. The various investigations carried out showed that these exceedances had no health consequences for either the public or the workers and that the situation resulted from a lack of rigour in the management and performance of the spent fuel package preparation operations, leading to a deficiency in radiological cleanliness in the NPPs.

With a view to resuming transport operations, EDF and COGEMA (now AREVA) presented ASN with an action plan aiming at improving the radiological cleanliness of the packages.

ASN conducted inspections on each of the EDF sites to verify reinforcing of the contamination checks (number of points checked and performance of a double-check by another company), the generalisation of good practices resulting from EDF's analyses, and an improvement in the radiological cleanliness in the packaging loading area. The resuming of spent fuel transport by rail was subject to these systematic inspections and the implementation of enhanced oversight by EDF. In early 1999, all the EDF sites had resumed their shipments of spent fuel to the La Hague reprocessing plant.

Since that time, the contamination limit exceedances notified by EDF have dropped greatly, with the way they have evolved being shown in the graph below:

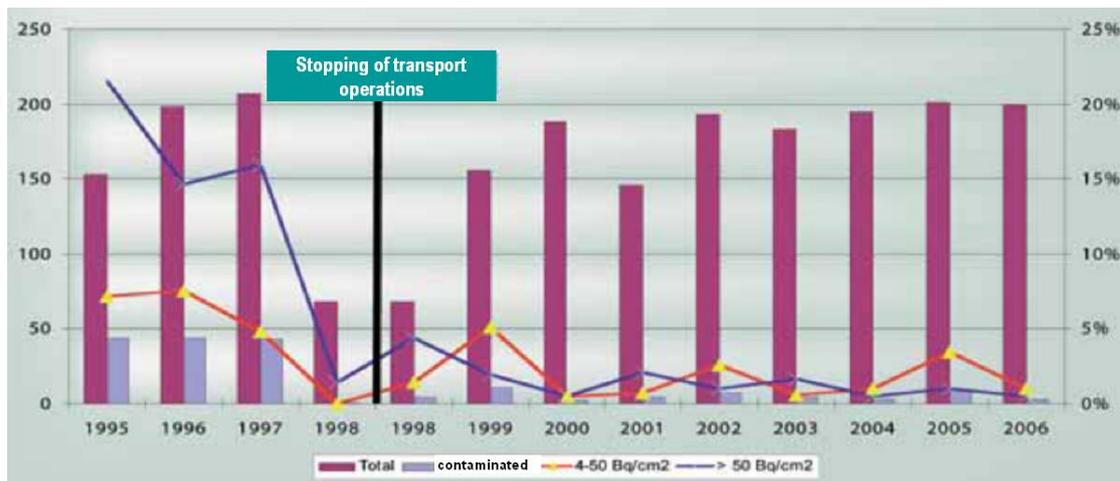


Figure 7: Contamination of wagons and trailers (situation as at 31<sup>st</sup> December 2006)<sup>12</sup>

In 2011, out of 202 spent fuel consignments, three surface contamination values above the regulatory limits were noticed. ASN considers that the situation has improved but vigilance must be maintained.

Apart from the contaminated wagons, ASN received some thirty event notifications between 2007 and 2011 corresponding to contamination limit exceedances of up to about one hundred Bq/cm<sup>2</sup>. These concerned:

- containers contaminated on their handling areas (passages for fork-lift forks, anchor points, etc.) or on the bottom surface of the package;
- empty, supposedly "decontaminated" containers, displaying points of contamination on their internal surface;
- points of contamination on the conveyance or the stowage means (vehicle platform, straps, etc.).

## 5. THE ORGANISATION AND SHIPMENTS OF PACKAGES IN SMALL-SCALE NUCLEAR ACTIVITIES

### 5.1. In the medical sector

#### 5.1.1. Shipments from healthcare facilities

Healthcare facilities are concerned by different types of radioactive material transport, including:

- the reception of packages of pharmaceutical radionuclides (<sup>18</sup>F, <sup>125</sup>I, <sup>131</sup>I, etc.) in type-A packages or excepted packages, and their return to the supplier;
- the reception of <sup>99m</sup>Tc generators in type-A packages and return of the generators after use.
- reception of sources for brachytherapy and radiotherapy (iridium wires, sources used in Gamma knife devices, etc.) and their return to the supplier after reaching the source's service life limit.

During its inspections, ASN has observed that the healthcare facilities have inadequate knowledge of the regulations, relying very often solely on their source suppliers. Several inspected facilities admitted that they did not train their personnel and were unable to present proof that the shipped packages were in conformity with the regulations. For example, the <sup>99m</sup>Tc generators are returned in excepted packages, without the healthcare facility being able to substantiate the classification of the package. Some facilities were unable to present "shipment files" for the return of brachytherapy sources. These shipments are usually organised by the source suppliers, but the contracts established between these suppliers and the facilities do not always specify who assumes the responsibility of consignor. When the package shipments are made by healthcare establishments, the inspectors have noted that the measures put in place and the procedures followed needed to be reinforced to guarantee compliance with the regulations.

➡ **Healthcare facilities must reinforce the measures in place to guarantee compliance with the regulations applicable to radioactive material transport. More particularly, personnel training must be improved and**

<sup>12</sup> Figures provided by EDF for transport operations carried out since 2006:

- 2008: 108 transport operations, no contaminated consignment;
- 2009: 186 transport operations, no contaminated consignment;
- 2010: 192 transport operations, two contaminated consignments (< 50 Bq/cm<sup>2</sup>);
- 2011: 202 transport operations, three contaminated consignments (one consignment < 50 Bq/cm<sup>2</sup> and two consignments >50 Bq/cm<sup>2</sup>).

*package shipment procedures drawn up or supplemented to guarantee compliance with all the applicable regulatory requirements.*

#### 5.1.2. Transport Safety Advisor (TSA) exemption for healthcare facilities

Healthcare facilities are exempted from having to designate a Transport Safety Advisor (TSA) on account of Article 6 of the TMD order [1] from the moment their radioactive material transport activities are limited:

- to excepted package shipments only, and the loading or unloading of these packages (the case most frequently encountered today);
- to the loading and unloading operations [*editorial note: without package preparation*] for radioactive material for which the UN (United Nations) numbers are 2915, 2916, 2917, 2919 or 3332, in the framework of transport operations carried out or commissioned by the suppliers who have their own transport safety advisor for class 7.

Thus the majority of healthcare facilities have not designated a TSA to date.

Yet ASN has observed in recent inspections that the used  $^{99m}\text{Tc}$  generators delivered to the healthcare facilities situated in the Paris region are recovered after a period of activity decay of just one week. The used generators in question contain significant residual activity that requires them to be considered like type-A packages.

The inspectors have also observed that some facilities go beyond simply loading and unloading, and actually make shipments of non-excepted radioactive material.

This practice implies that the facilities concerned designate a TSA in accordance with the provisions of paragraph 1.8.3 of the ADR.

In view of the shortcomings observed during inspection as described in the preceding paragraph, and this new practice, ASN is wondering whether the exemption regarding the designation of a transport safety advisor is really appropriate.

➤ *ASN wonders whether it is appropriate to maintain in the regulation the TSA exemption for healthcare facilities. This provision, which is misinterpreted, leads to noncompliance with the regulations. ASN has initiated discussions on this subject with the French Nuclear Medicine and Molecular Imaging Society (SFMN).*

The early return of used  $^{99m}\text{Tc}$  generators also has an impact in terms of radiation protection. It increases the dose received by the carriers returning the packages and is in contradiction with the 2nd principle mentioned in Article L.1333-1 of the Public Health Code which indicates that "*the exposure of persons to ionising radiation resulting from one of these activities or interventions must be maintained at level that is as low a reasonably achievable, given the technical state of the art, economic and social factors and, where applicable, the desired medical objective*".

ASN sent a letter to the  $^{99}\text{Tc}$  supplier concerned asking it to justify the practice of recovering the generators after only one week of decay and to evaluate the radiological impact of this practice. To date, ASN has not yet received a reply.

### 5.1.3. Shipments departing from producers of radionuclides for medical uses

The ASN inspectors' main findings during inspections into radiopharmaceuticals transport concern:

- shortcomings in the on-vehicle safety kit: faulty lamp, no eye-rinsing fluid, extinguisher verification date expired, no placard with contact details to leave in the vehicle in case of parking, etc.
- the lack of a periodic check of the vehicle to determine the level of contamination,
- the use of magnetic panels and/or placards, for which the fire resistance of over 15 minutes has not been demonstrated.

These latter two types of deviation are common to the deviations observed with the road transport carriers responsible for transporting packages for industrial radiography or for the nuclear cycle (see paragraph 5.2).

For information, the diagram below breaks down the main subjects of the follow-up letters issued by ASN further to the 44 inspections of Fluorine-18 carriers in 2009, 2010 and 2011. The number of deviations relating to the transport documents or insufficient stowage of packages is falling. The absence of an annual report from the transport safety advisor observed several times in 2009 seems to have been corrected these last years.

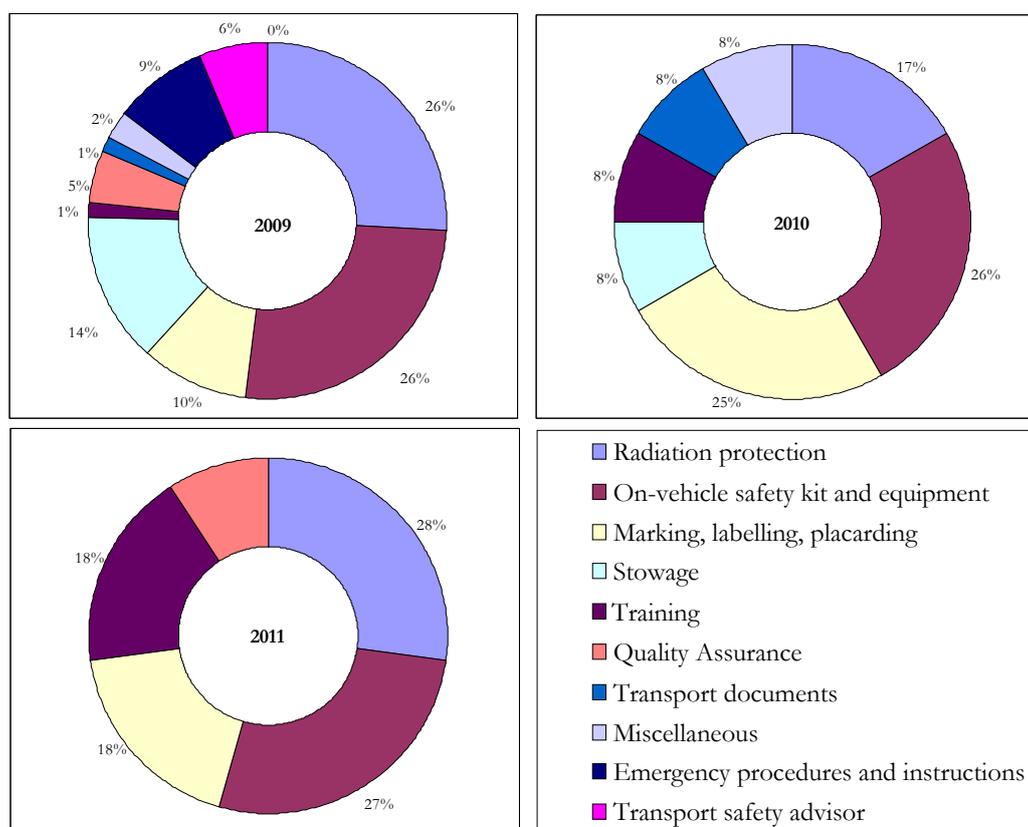


Figure 8: Breakdown of the main subjects of the follow-up letters issued by ASN further to the inspections of Fluorine-18 carriers (44 inspections recorded)

## 5.2. In industry

### 5.2.1. Gamma ray projectors and gamma ray densitometers

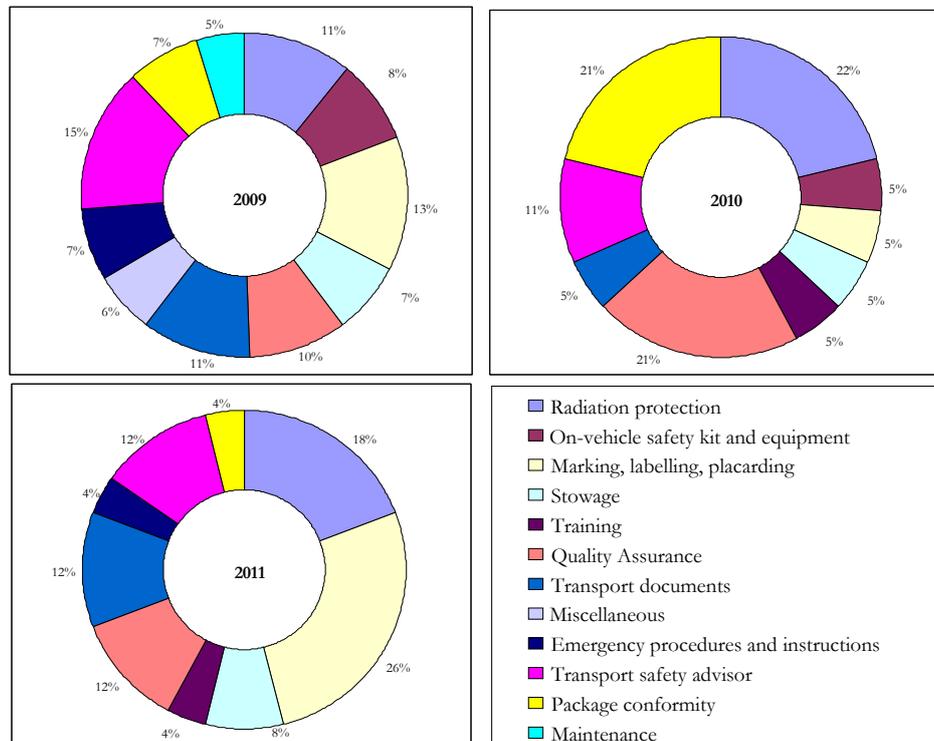
Verification of the transport of gamma ray projectors and gamma ray densitometers was one of ASN's priority inspection themes in 2001, 2005 and 2006. Improvements have been observed. Today, the main findings of the ASN inspectors during inspections of independent carriers of gamma ray projectors and gamma ray densitometers concern:

- in the same way as for the transport of radiopharmaceutical packages:
  - shortcomings in the on-vehicle safety kit: faulty lamp, no eye-rinsing fluid, extinguisher verification date expired, no placard to display if parking, etc.;
  - the lack of a periodic check of vehicle non-contamination;
  - the use of magnetic panels and/or placards, for which the fire resistance of over 15 minutes has not been demonstrated;

- findings specific to the transport of gamma ray projectors:
  - failure to tie-down the depleted uranium collimator during transport or its transport as a conventional package instead of an excepted package (or as an excepted package instead of a type-A package);

The lack of radiological protection programmes is also regularly observed.

For information, the diagram below shows the subjects of the main demands of the follow-up letters issued by ASN further to the 42 inspections of independent gamma ray projector and gamma ray densitometer carriers in 2009, 2010 and 2011.



**Figure 9: Breakdown of the main subjects of the follow-up letters issued by ASN further to the inspections of gamma ray projector and gamma ray densitometer carriers (42 inspections recorded)**

The 5% to 12% of deviations associated with the transport documents are partly linked to a change in the regulations. The order of 1<sup>st</sup> June 2001 amended (the "ADR" order) included a specific provision for the transport of gamma ray projectors: gamma radiography devices in accordance with standard NF M 60-551 could be transported under a permanent notification of radioactive material shipment valid for a maximum of one year. This order was repealed on 1<sup>st</sup> July 2009 by the "TMD" order of 29<sup>th</sup> May 2009. Since the end of 2009, the ASN inspectors regularly find permanent shipment notifications even though they are no longer authorised.

### 5.2.2. Lead analysers

ASN regularly inspects entities that possess sealed source devices for detecting lead in paint. Specific inspection campaigns were thus carried out, for example, in the Provence, Alpes, Côte d'Azur (PACA), Languedoc-Roussillon and Pays-de-la-Loire regions in 2011.

The inspectors observed several deviations in the transport of these devices (consigner not identified on the transport package, lack of shipment notification, etc.). Consequently, in 2012 ASN sent a letter to the national federations of real property inspectors reminding them of the regulatory requirements applicable to the transport of these devices. Alongside this, the inspections of the suppliers of these devices are designed to check their organisation, the conformity of device shipments and the instructions given to their customers.

### 5.3. "Small waste producers"

The national radioactive waste management agency (ANDRA) organises one collection of radioactive waste generated by about a thousand "small waste producers" (medical laboratories, hospitals, universities, research laboratories, municipalities, etc.) that use radioactivity in their activities. These wastes are packaged in excepted, industrial or type-A packages.

Collection generally takes place as follows:

- the producer asks ANDRA to collect the waste;
- ANDRA provides the "small waste producer" with the packaging and transport labels. The waste producer loads the content into the packaging and affixes the labels as instructed in the waste collection guide drawn up by ANDRA.
- ANDRA subcontracts the carriage operations to a single carrier who goes to the producer's site to collect the packages. The carrier performs the radiation protection inspections, checks the labelling and fills in the DEMR (Radioactive Material Dispatch Note). The DEMR is signed by the producer.

The "small waste producers" are the package consignors. The instructions to follow and the restrictions on the accepted waste are described in the waste collection guide drawn up by ANDRA.

The "small waste producers" often have little knowledge of the regulations applicable to the transport of radioactive material and are not always aware of their responsibilities as consignors of radioactive material packages.

One can question the sufficiency of the material and human resources available to the producers to verify the conformity of the packages during their preparation (conformity of packaging closure, condition of the packaging (seals in particular), packaging adapted to the transported material).

Once the wastes have been collected, they are grouped in an overpack and transported to a processing facility. In 2011 the operators noticed a very strong smell of solvent when opening the overpack. The packages were intact. The analysis of the causes did not however determine whether this event was linked to a nonconforming package, aging of the packaging or some other cause.

## 6. CARRIAGE OF THE PACKAGES

Few events concern traffic accidents occurring during the carriage of packages (by road, rail, air or sea). The events notified to ASN between 2007 and 2011 correspond to:

- 15 events corresponding to **road accidents** involving vehicles carrying radioactive packages and having no consequences on the packages: minor collisions, vehicle rollover or minor accidents (these events concerned medical radionuclide packages, the transport of measuring devices (gamma ray projectors, gamma ray densitometers, or others). Two events involving packages of radionuclides for research or industry). These events were rated level 0 on the INES scale. In most cases the packages were able to be transferred to another vehicle and routed to the consignee;
- 2 events involving **fires in vehicles** containing excepted packages (engine fire and vehicle having caught fire after an accident). These events were rated level 0 on the INES scale.
- 2 **on-site transport** events: an empty truck collided with the wall of a facility, and a handling truck transporting radionuclides ran into a car parked on a no stopping area;
- **derailment of wagons** of UF<sub>6</sub> in 2009, with no consequences for the packages (event below scale);
- a **road accident rated level 1 on the INES scale** involving a van transporting a type-B package containing radioactive sources in special form. Following a collision with a heavy goods vehicle, the van burnt. The checks carried out by the CMIR (mobile radiological intervention unit) and IRSN showed that package integrity was preserved (see incident notice in appendix 2).

Incidents occurring in airport freight zones are also noted, and described in the following paragraph.

## 6.1. Air transport

Two noteworthy incidents associated with the transport of radioactive material involved French airports:

- on 17 August 2002 at Roissy CDG airport, a type-A package containing capsules of iodine 131 used in nuclear medicine fell from the truck that was transporting it to the aircraft. It was crushed by vehicles on a service road linking two of the airport terminals. This resulted in a loss of containment and the dispersion of radioactive material on the road. The road surface was contaminated. The medical examinations of the intervening personnel revealed very slight contamination, with no consequences on their health. The event was rated level 1 on the INES scale.

The reactive inspection that followed the event revealed that the packages are rarely tied-down during their transport on the airport, and that the personnel is not sufficiently aware of the principles of radiation protection and of the precautions to take during handling and in the event of an incident or accident.

- in January 2002, a level 3 incident was notified by a Swedish consignor. A type-B package containing iridium-192 pellets shipped by air from Sweden to the USA and in transit at Roissy CDG airport, displayed an abnormally high dose rate: 4 mSv/h at a distance of 25 metres (instead of the authorised 2 mSv/h in contact with the package).

When the package was opened, a packaging error was discovered: the lids of two of the three cases were unscrewed, numerous pellets had escaped from the horizontally positioned cases during transport and had spread into the gap around the lid and the package. The approval certificate specified that these internal cases could only be opened by a destructive means. Screw fastening was not planned for.

An American driver received a dose of 3.4 mSv in 10 minutes. Medical analyses also revealed that two employees of the air carrier at Roissy CDG airport probably received doses of about 30 mSv and 100 mSv during package transit.

ASN carried out a reactive inspection on the premises of the carrier Federal Express (Fed Ex) at Roissy, and reiterated the fact that since 1st July 2001, operations relating to air transport of radioactive material must be governed by a radiological protection programme (§ 1-1.3.2 of the technical instructions of the ICAO).

In addition to these notable incidents, ASN regularly receives notifications of events relating to packages suffering damage in airport freight zones during handling (damage resulting from falls, impacts, excessively tight lashing, crushing by a heavier package, etc.). In the majority of cases these events have no real consequences on the public or the environment and do not lead to any loss of containment. They are most often rated below the scale or level 0, although a few incidents rated level 1 involving crushed packages can be noted.

Each year ASN and the DGAC<sup>13</sup> hold regular joint inspections, announced or unannounced, of the different operators in the air transport of radioactive packages. The inspected companies include airlines, airport ground handling agents, such as the companies ensuring the freight, the transfer of packages between the freight area and the aircraft, loading and unloading of aircraft.

The airlines must be authorised for the transport of hazardous goods by the DGAC ("air transport certificate" delivered by the DGAC in accordance with Article R133-1-1 of the Civil Aviation Code). They are regularly audited by the DGAC. The airport ground handling companies, however, are not subject to authorisation.

Some of these companies concerned by large and regular volumes of radioactive packages have made significant progress over these last years and set up good practices, for example:

- radiological protection programme providing for, among other things, dosimeters for the personnel and a closed storage room with a radiological measuring monitor;
- training in emergency situation instructions and organisation of an exercise involving the falling of a radioactive package.

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<sup>13</sup> Direction Générale de l'Aviation Civile (General Directorate for Civil Aviation) (Ministry of Ecology, Energy, Sustainable Development and Land Planning).

Among the other companies however, very few have a radiological protection programme. Many of them display a huge lack of radiation protection culture, resulting in deviations from the procedures established by these companies. For example, during an unannounced inspection, the ASN inspectors observed several deviations in a freight zone:

- a radioactive package was stored in a "hazardous material - other classes" room instead of the "class-7 related material" room;
- this package was moved, first by "man-handling", then, further to the remarks of the inspectors, on a wooden pallet using a fork-lift truck, but without wrapping it in film and without using the metal handling crate provided for handling class-7 packages;
- the validity of the training certificate of the person who handled the package had expired;
- the personnel handling the radioactive material packages were not wearing the dosimeters at their disposal.

An information seminar for the airport companies was organised by the DGAC and ASN in early 2010. The aim of this seminar was to recap on the various regulatory requirements applicable to the air transport of radioactive material, to recall the main events at airports involving radioactive packages and to obtain the testimonials of airport ground handling companies that had implemented good practices.

➤ *ASN is wondering about the possibility of subjecting airport ground handling companies to a system of authorisation/notification. This could have the advantage of obliging them to designate a PCR<sup>14</sup> and improve worker radiation protection. This point must be examined in relation with the question of shipment refusal.*

To be noted:

CIS BIO IBA, the main consignor of <sup>99m</sup>Tc generators in France has planned to use a new packaging design in the near future. This should be more resistant to the handling conditions in the airport ground handling companies. The company moreover plans for the production of 3 new generators with a precise activity in October 2012 in order to evaluate the dosimetric impact of this new packaging for the transport operators.

## 6.2. Maritime transport

The port personnel are not very accustomed with the handling of certain radioactive packages. Thus, during the loading of empty packages on a ship in the port of Cherbourg, the inspectors observed difficulties in correctly positioning and securing a package in the cradle in the ship's hold. The difficulties in positioning the package required the presence of more than ten people in the ship's hold for this operation.

Furthermore, on the day of the inspection, the operators had difficulty in setting and using the torque wrench for tightening the package on its stowage cradle. The system got blocked on a stowage screw and it was necessary to change tool to resume the stowage of the package. This change made it necessary to verify all the tightening torques of the previously tightened screws.

In the case of a package displaying a high dose rate, an operation of this duration in contact with the packages and involving as many people goes against the principles of good dosimetry control.

In the past, some packages could not be shipped because the transmitted package handling procedure was inappropriate for the conditions of transport. The packages were to be loaded onto the ship already installed on their road transport skid. The handling was to be carried out using handling devices provided on the semi-trailers. Some of these devices were inaccessible, making it impossible to handle packages on the road transport skid. The packages therefore could not be transported.

As with air transport, the radiological protection programmes and the personnel's awareness of the risk associated with radiation are found to be inadequate, particularly for the crew and the dockers.

➤ *The anticipation and preparation of the transport operations must be reinforced to enhance the safety of their performance and radiation protection. They must take into account the realities of the infrastructures and the facilities.*

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<sup>14</sup> See paragraph 6.4.4

### 6.3. Rail transport

In 2006, the ASN inspectors had observed that the SNCF had put in place a guidance to assist the drafting of radiological protection programmes, but it had not been applied in all the facilities concerned (out of 46 sites identified by the SNCF, 4 did not have a radiological protection programme and 13 sites had a document under preparation). This deviation seems to have been corrected. The need to update these programmes must nevertheless be analysed regularly.

The inspectors had also noted the absence of training of part of the personnel likely to work near the wagons containing radioactive material.

Lastly, during inspections carried out in the marshalling yard, the ASN inspectors noted that the on-site emergency plan of some yards did not specifically integrate a scenario including class 7.

ASN has scheduled marshalling yard inspections for 2013. The radiological inspection programme, the training and the emergency procedures shall be examined particularly attentively.

### 6.4. Road transport

#### 6.4.1. Verification of vehicle non-contamination

Paragraph 7.5.11 of the ADR (CV 33 5.3) specifies that: "*A vehicle and equipment used regularly for the carriage of radioactive material shall be periodically checked to determine the level of contamination. The frequency of such checks shall be related to the likelihood of contamination and the extent to which radioactive material is carried*".

During the various road transport carrier inspections, the inspectors have noted that many of them were not anticipating this requirement.

The companies transporting ISO 20" containers loaded with contents such as very low level (VLL) waste or contaminated tools for EDF, indicate that these inspections are carried out in the NPPs when the shipments are made, something that EDF does not confirm. It therefore seems that these inspections are not carried out.

Very few companies working in small-scale nuclear activities perform these inspections.

ASN emphasises that the frequency of vehicle contamination checks must be proportionate to the risks of contamination associated with the content and the loading conditions (they must therefore be performed regularly when loading in BNI's or areas under radiological surveillance, whereas less frequent inspections may be tolerated when the loading operations concern gamma ray projectors or lead analysers on work sites "reputed to be clean").

**⇒ *The carriers should specify the frequency of check of non-contamination in their vehicles in their radiological protection programme. This point will be verified during the inspections.***

#### 6.4.2. Parking vehicles

ASN's attention was drawn in 2011 following the notification of an event relative to the parking of a vehicle loaded with radioactive material without surveillance and with no information enabling the carrier to be contacted in case of emergency.

According to paragraph 2.3.1.1. of appendix 1 of the TMD order, "*parked vehicles must be positioned so as to avoid to the greatest possible extent any risk of being damaged by other vehicles. They must be able to be removed without manoeuvring being necessary. When the driver leaves the parked vehicle, he must place inside the cab a placard that is clearly visible from the exterior, indicating:*

- *either the name of the company, the telephone number and, if applicable, the address at which one of the heads of the company ensuring the transport can be contacted at any time (if any of this information is indicated on the vehicle itself, the drivers does not have to copy it onto the placard);*
- *or the name of the driver, a telephone number and, if applicable, the address at which he can be contacted immediately*".

During ASN's inspections on the road transport carriers' premises or during shipments, few drivers were able to present a placard such as is specified in paragraph 2.3.1.1. As the inspections were carried out during shipments or on the carriers' premises and not on parking areas, this does not constitute a deviation, since the placard is required by the ADR when parking on the public road; the inspectors do nevertheless wonder how this placard could be displayed in the event of parking if, when the vehicles depart, the drivers do not have a pre-completed placard or the wherewithal to fill one out.

➤ *ASN is considering proposing a modification to the TMD order to make it obligatory for the on-vehicle safety kit to include a placard such as described in paragraph 2.3.1.1 of appendix 1 thereof.*

#### 6.4.3. Role of the TSA

During their inspections, the ASN inspectors have had the opportunity to meet many committed and motivated transport safety advisors (TSA). The inspectors have however noted that the improvement proposals made by the TSAs in their annual report were often poorly taken into account or not at all, without analysis or justification. The regulations provide for the possibility of using a TSA from an outside company. A study carried out by the CIFMD<sup>15</sup> has shown that in some companies, for the transport of hazardous goods, a given person could be the external TSA for a very large number of companies - up to about one hundred. This number seems poorly compatible with satisfactory fulfilment of the TSA's missions.

This practice seems less widespread in the area of class-7 transport. Nevertheless, the inspectors have found that some TSAs had never visited some of the companies under their care.

In order to have a more precise picture of the activity of the TSAs, this aspect has been adopted as an inspection theme for the ASN's 2012 annual inspection programme and will be continued in 2013. This should provide a clearer view of the role of the TSAs in the class-7 domain and enhance their awareness of their duties.

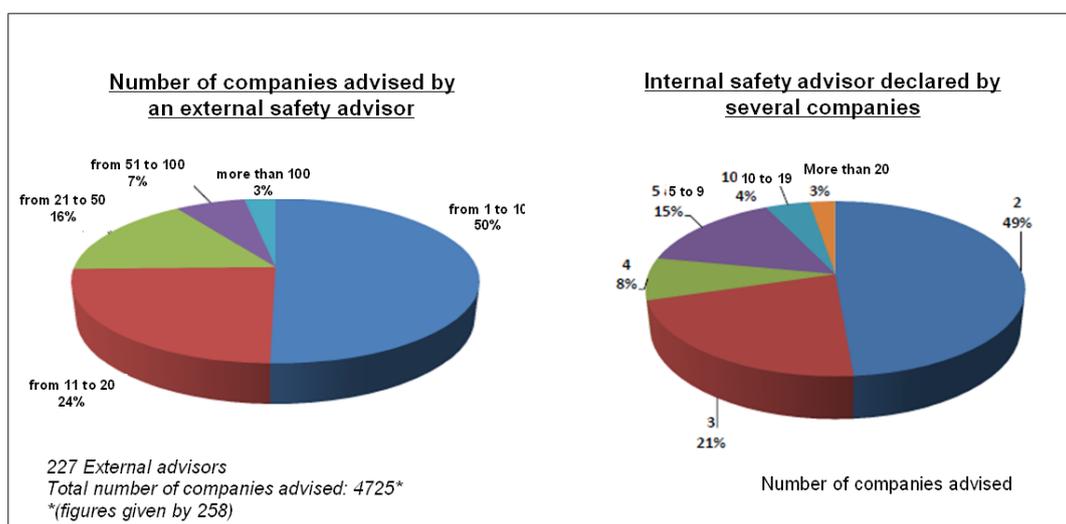


Figure 10: Number of companies advised per TSA (all hazardous goods classes combined).  
Data sourced from a CIFMD study published in May 2012 (available on [www.cifmd.fr](http://www.cifmd.fr))

#### 6.4.4. Transport carriers and radiation protection

The regulations provide for the transport of radioactive material to be governed by a radiological protection programme. This is a practical document that provides the framework for the radiological aspects of the transport of radioactive material and describes all the measures implemented to ensure that the radiological protection measures are duly taken into consideration. This means defining radiation protection objectives and providing the necessary infrastructure and resources to achieve these objectives. This process must also integrate compliance with the package containment and integrity requirements, written into the modal regulations. The nature and scale of the measures implemented in this programme must be commensurate with the levels and probabilities of exposure to radiation.

The inspectors have observed that the radiological protection programmes developed by the road transport carriers do not always meet these objectives. They are not systematically subject to analysis. The doses received by road transport drivers can sometimes be high, particularly in the medical sector (according to an IRSN study conducted in 2009, the dose received by the carriers can reach the annual occupational exposure limit of 20 mSv/year).

<sup>15</sup> CIFMD : Interprofessional Committee for the Development of Training in the Transport of Dangerous Goods (association that groups the professional trade federations of loaders and carriers involved in the land transport of dangerous goods). The cited study was carried out and published by the CIFMD in May 2012 and is available on [www.cifmd.fr](http://www.cifmd.fr).

- ⇒ *The entities involved in the transport of radiopharmaceutical packages should undertake a joint initiative to optimise operator radiation protection at all stages of the transport process. This initiative must include reflection on the organisation of carriage and transfers during transport, on the measures planned during in-transit storage and in the transport hubs and on package conditioning and the loading plan at shipment (for example: loading that avoids complete unloading and reloading of all the packages at each hub).*

Note: The transport companies do not always have a person competent in radiation protection (PCR)<sup>16</sup> at their disposal. As carriers at present are not subject to authorisation or notification under the Labour Code (see paragraph 2.4), ASN has no sound regulatory basis to date for imposing the designation of a PCR.

Furthermore, regulatory modifications should be made to the order of 26th October 2005 relative to the conditions of training of the PCR and the certification of the trainer in order to make the training of PCRs evolve. The provisions of this new draft should allow the introduction of specific training for PCRs working in transport activities and establish a graded approach in this training.

## **7. PACKAGING MANUFACTURE AND MAINTENANCE**

### **7.1. Manufacture of ASN-approved packages**

#### **7.1.1. "Manufacturing" inspections carried out by ASN**

The ASN inspectors conduct inspections on the premises of the manufacturers of packagings used as ASN-approved packages, but also at the manufacturers of packagings used for packages for which an approval is not required in order to check that the packing is manufactured in accordance with the design described in the safety analysis report.

A manufacturing defect could effectively jeopardise the safety of the package model and have serious consequences. This problem can be illustrated by a deviation observed by ASN inspectors during the examination of the safety analysis report of a package designed to transport cylinders containing uranium hexafluoride. While the calculations demonstrated the mechanical resistance of the packaging to the drop tests, during the tests performed on a specimen (scale-1 mock-up), a weld failed, reducing the resistance of the packaging in the event of fire.

The investigation that followed the tests showed that this difference between the theoretical calculations and the tests was caused by a manufacturing defect on the specimen: the welding process required by the specifications had not been applied. This welding error occurred during the manufacture of the specimen, but could have occurred during the manufacture of the packaging, thereby jeopardising its resistance in an accident situation.

During the manufacturing inspections of a packaging, ASN checks in particular that the design requirements of the safety analysis report match the manufacturing specifications and the operating and inspection procedures. The quality assurance implemented and the conformity with the safety analysis report specifications must be able to be demonstrated at each manufacturing step and the following steps in particular:

- the procurement of material conforming to the specifications (grade, mechanical characteristics, etc.) and their conditions of storage before use;
- the performance of manufacturing procedures;
- compliance with the manufacturing steps, the stopping points and the in-process inspections;
- the detection and traceability of deviations, their processing and the analysis of their impact on the safety of the packaging;
- if the manufacturer uses subcontractors, the role and responsibilities of each operator.

Since 2006, ASN has inspected the manufacture of fifteen packaging designs for which an ASN-approval application had been requested<sup>17</sup>. These inspections concerned varied packages intended to contain fuel, waste, uranium

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<sup>16</sup> The designation of a PCR is a mandatory requirement of the Labour Code for any nuclear activity involving sources of natural or artificial origin leading to a risk of exposure of the personnel working in the organisation. Under the responsibility of the employer, the PCR participates in the implementation of measures protecting against ionising radiation and ensures compliance with them. Its duties, defined in the Labour Code, include performing technical checks of radiation protection, participation in the training of personnel - whether salaried or not - in radiation protection, and the monitoring of worker dosimetry. The PCR is the point of contact with the regulatory organisations and must hold a certificate delivered on completion of training in radiation protection.

hexafluoride, sources and effluents. All packages corresponding to new designs were inspected. The manufacture of older-design packages was subject to sampling inspection.

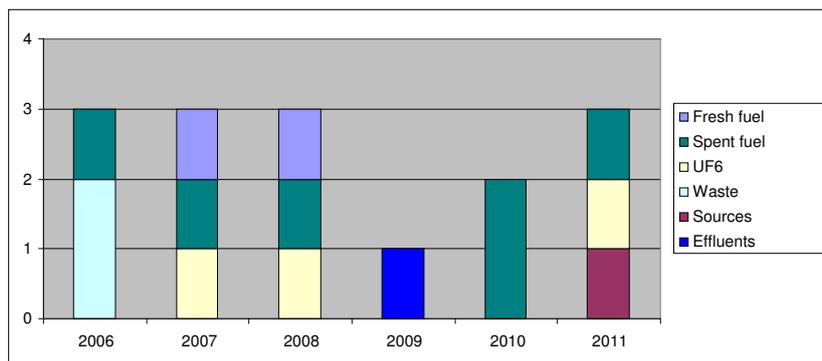


Figure 11 : Number of "manufacturing" inspections performed by ASN since 2006

These inspections reveal that the organisation and means implemented by the packaging designers and manufacturers are globally satisfactory and adapted to the safety issues and regulatory requirements. Several deviations have nevertheless been noted.

In the past, these deviations concerned:

- the procurement of the material: deficiencies in acceptance inspection traceability, non-exhaustive specification requirements, etc.,
- the processing of deviation sheets: sheets not closed, failure to validate the analysis of the impact of the deviations on safety, etc.,
- the identification of the personnel training and/or qualification requirements;
- during modifications, in manufacture, with respect to the safety analysis report: impact studies absent or incomplete,
- quality assurance,

Improvements have been observed in these areas at the packaging manufacturers over the last few years, but quality assurance deficiencies still remain, for example:

- deficiencies in the traceability of exchanges and formal validations between the package designer and manufacturer (non-compliance with stopping points for example),
- insufficient traceability of document updates,
- incomplete application of the internal quality baseline requirements (absence of supplier audits or internal audits).

Two manufacturing deviations that could have had consequences on the leak-tightness of their package are nevertheless noted, and described in the following paragraph.

<sup>17</sup> The number of inspections performed during package manufacture varies with the years according to the number of new packages manufactured, and must be associated with the maintenance inspections performed on existing packages.

## 7.1.2. Manufacturing deviations that could call into question the leak-tightness of the package?

### 7.1.2.1 Manufacture of a transport packaging for radioactive sources

In 2011, the ASN inspectors noted a deviation in the manufacture of a packaging for transporting radioactive sources (fissile and non-fissile): the results of the dimensional inspections indicated that the dimensions of the seal grooves were outside the tolerance ranges defined in the manufacturing file on five of the ten packages manufactured. These dimensional inspections had been carried out by one of the manufacturer's subcontractors. The deviations were detected by neither the manufacturer nor the packaging owner, the manufacturer's end-customer.

At the request of ASN, this deviation formed the subject of a significant event notification rated level 0 on the INES scale by the packaging owner. The investigation revealed that the inside diameters of the seal grooves of the rear plugs of five packagings were outside the tolerances set in the manufacturing file. As the tolerance ranges set in the packaging manufacturer's manufacturing file are more stringent than those defined in the safety analysis report, four packagings remained in compliance with the safety analysis report. Nevertheless, the dimensions of the seal grooves of the plug of the fifth packaging were outside the tolerances specified in the package design safety analysis report. The packaging was therefore noncompliant with the approval certificate (maximum deviation of 0.6%). The packaging concerned was used for several transport operations between March and June 2011 before the deviation was detected (the leak-tightness test result complied with the criterion specified in the safety analysis report and the approval certificate under routine transport conditions).

ASN asked the applicant to demonstrate that the incorrect sizing of the seal grooves had no impact on the leak-tightness of the package, particularly at very low temperatures and under accident transport conditions, and to integrate the result in the approval extension application. Delivery of the certificate will depend on the results of this analysis, which is currently in progress.

### 7.1.2.2 Manufacture of a transport packaging for research fuel

In 2008 ASN was informed that premature wear of the closing system of the plug of a packaging had been observed during preparation for an on-site transport operation. The plug forms part of the packaging containment enclosure, therefore this wear was likely to affect the package containment.

The analyses that followed detection of the deviation would appear to indicate that the screw thread inserts installed during manufacture of the packaging did not comply with either the manufacturing specifications or the package design safety analysis report. This deviation would have led to wear of the screws (as the thread of the inserts did not match the thread of the screws).

## 7.2. Manufacture of packages not subject to approval

Inspection of the manufacture of packages not subject to approval has been one of ASN's priority inspection themes since 2010 and has been the subject of tightened inspections since 2004, when the IAEA conducted its TranSAS (Transport Safety Appraisal Services) mission in France (see appendix 3). The tightening of inspection of the conformity of packages not subject to approval was the focus of recommendation S22 of this mission.

Since 2010, ASN has thus carried out 22 inspections of packaging suppliers or manufacturers of packagings intended to be used in industrial or type-A packages (6 in 2010, 8 in 2011 and 8 in 2012). The inspections carried out at the consignors or packaging users come in addition to these figures.

During these inspections, the inspectors check that the tests prescribed in the regulations have been carried out and they focus on the safety demonstrations that allowed the company to deliver the certificate of conformity with a package design.

The various inspections have shown that these elements are often either not available on the premises of the entities concerned, or they are incomplete. The areas for improvement concern the following points in particular:

- the description of the authorised contents per type of packaging;
- the representativeness of the tests performed;
- compliance with the regulatory radiation protection requirements.

The inspectors have also noted incorrect application of paragraph 6.4.5.4.4 of the ADR relative to containers meeting standard ISO 1496-1:1990. This paragraph provides for alleviation in the safety demonstration required in cases where containers that comply with the abovementioned standard are used as type IP-2 or IP-3 packagers. It has been found that several suppliers of containers demonstrated the conformity of containers intended for use as type-A packages on the basis of this paragraph. However, this paragraph is only applicable to industrial packages loaded with a solid content and cannot be extended to type-A packages.

This point was explained by the inspectors who went back to the companies concerned one or two years later to check that it had been properly understood and taken into consideration. Several companies indicated that they no longer supplied containers intended for use as type-A packages and limited themselves to industrial packages.

This deviation essentially concerns containers complying with standard ISO 1496-1:1990. But more broadly speaking the ASN inspectors generally observe an insufficiency in the demonstrations of conformity of industrial and type-A packages.

In the inspection follow-up letters, ASN has asked the packaging suppliers concerned to prove the conformity of the packagings with the regulations.

### 7.3. Packaging maintenance

Packaging maintenance is an important aspect of the measures to ensure transport safety. The packagings must undergo periodic maintenance with obligatory replacement of seals, verification of the condition of certain parts, etc. Failure to perform the periodic maintenance inspections of the packagings means that the design-basis behaviour cannot be guaranteed, in an accident situation for example.

Maintenance inspections are carried out regularly, especially on packagings which have been in circulation for a long time (more than 20 years).

#### 7.3.1. Compliance with maintenance requirements

ASN has been informed of, or has observed during inspection, several deviations from the maintenance requirements for packages used to transport radioactive material. Thus:

- Several deviations from the maintenance requirements have been observed on the premises of a nuclear licensee:
  - o During an inspection in 2007, the inspectors asked to see the records of the last maintenance operations on several units of a type-B fissile packaging in order to verify compliance with the applicable requirements. They found that the maintenance check-list provided for were not filled out. Moreover, the inspectors estimated that the monitoring of the outside contractor responsible for the maintenance of these packagings was insufficient. More specifically, the last audit of the company dated back 8 years. Deviations similar to the points raised at the inspection had already been observed.
  - o During an inspection in 2008, a nuclear licensee was unable to demonstrate the conformity of the documentation concerning the maintenance of a tank of radioactive effluents with respect to the safety analysis report submitted in the framework of the currently valid approval.
  - o In 2008, notification of noncompliance with the maintenance frequency of a waste packaging (no transport operations involved). The safety analysis report of the package design provided for annual maintenance, even if the packaging was not used. The maintenance of one unused packaging had not been carried out for 2 years.

Today, the licensee checks the consistency of the user's manual and the maintenance specifications with respect to the safety analysis report. A procedure for recording this verification has been put in place to improve the traceability of these actions. The maintenance operations for all these packagings belonging to the licensee's different entities have been subcontracted to the same company since 2008, in order to improve monitoring of the operations.

- In 2011, notification of noncompliance with the maintenance frequency of 5 overpacks for UF<sub>6</sub> cylinders. The package design safety analysis report provides for maintenance every 5 years or 50 transport operations. The 5 overpacks have each been used for between 27 and 63 transport operations without undergoing any maintenance. The consignor in question will set up a computerised system with a counter for the number of transport operations per packaging and sending warnings before the maximum permissible number has been reached. The system blocks the transport if this number is exceeded.

- In 2011, notification of exceeding of the date limit for weighing thermal covers<sup>18</sup> intended for the transport of another overpack design for UF<sub>6</sub> transport. It turned out that the procedure used by the consignor companies did not include the check of conformity of the three-yearly maintenance of the thermal covers. The covers are now accompanied by a document certifying their conformity and indicating the utilisation expiry date. The shipment procedures in question have been updated to include the verification of thermal blanket conformity.

Deviations in carrying over the requirements of the safety analysis report to the maintenance manual or operating procedures have also been notified. Thus in February 2011, an owner of overpacks for transporting UF<sub>6</sub> cylinders informed ASN that a safety analysis report requirement concerning the qualification of the operator responsible for inspecting the welds during packaging maintenance was not satisfied. This deviation meets that of carrying over the safety analysis report requirements to the user's manual described in paragraph 3.2.3 and area of improvement No. 1.

### 7.3.2. Subcontracting maintenance

During an inspection in 2009, a nuclear licensee that subcontracted the maintenance of its packagings to another company was found to **fail to assume ownership and analyse the deviations**. The anomaly processing sheets opened by the service provider when a deviation was detected during maintenance were only subject to documentary management on the service provider's premises, and the licensee did not even keep a copy of them. Progress has been made in this area, and today the sheets are signed and analysed by the licensee. (See paragraph 4.3.1 on subcontracting for package preparation).

In 2011, an owner of overpacks for transporting UF<sub>6</sub> cylinders informed ASN that a safety analysis report requirement concerning the qualification of the operator inspecting the overpack welds during maintenance was not satisfied (criteria of the ASME standard required). The event notification indicated that the weld inspection was nonetheless carried out by a COFREND qualified operator and justified the absence of consequences on safety through the equivalence of the verification criteria required by the ASME standard and by the COFREND qualification.

During the reactive inspection that followed the notification, the inspectors realised that the information communicated to ASN was incorrect: between 7th May 2010 and 18<sup>th</sup> February 2011, the visual inspections of the overpack welds during maintenance were carried out by personnel who did not hold the COFREND qualification and without complying with the criteria of the ASME standard. This deficiency in the analysis of the event illustrates the **lack of knowledge of the subcontractor's procedures**.

### 7.3.3. Conditions of storage of empty packagings

In 2009, an inspection in order to control the conformity of a package used for transporting diverse non-irradiated nuclear material (uranium powder, metallic uranium, fuel elements, etc.), revealed deterioration of part of the wood of the shock-absorbers and levels of humidity exceeding the safety analysis report specifications.

A change in the humidity of the wood is liable to change its shock-absorbing capacities and therefore affect the preservation of the safety functions of the package in the event of impact.

The packaging design did not provide for watertight welds on shock absorbers. This design factor associated with prolonged storage of the packagings outside, in unfavourable weather conditions, would have led to this abnormal humidity. Transport operations with these packagings were suspended. The packaging shock absorbers are now always welded to prevent any infiltration of humidity.

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<sup>18</sup> This check weighing serves to verify that the weight of the thermal blanket has not increased by more than 10% with respect to its initial weight due to the uptake of humidity, otherwise the blanket would have to be dried and its seams re-sealed.

#### 7.3.4. Integrating experience feedback on the use and maintenance of the packagings

Applicants submit approval applications to ASN for packagings that are used abroad by foreign licensees. The maintenance of these packagings is sometimes also carried out by these foreign licensees and the French applicants have no feedback concerning their maintenance. Yet experience feedback on the use and maintenance of the packagings can reveal problems not detected or anticipated at the design stage or during the examination of the safety analysis report, such as problems linked to the aging of packaging components, etc.

⇒ *Applicants shall provide the experience feedback from the use and maintenance of the packagings with any approval extension request. This experience feedback shall be studied as part of the application examination.*

## 8. EXAMINATION OF APPROVAL APPLICATIONS

### 8.1. The applicant's guide

To obtain a certificate of approval for a package design, the applicant must prepare a safety analysis report demonstrating that the design satisfies the international regulatory requirements and submit it to the safety authorities concerned. The international regulations however do not define all the requirements or safety parameters to be considered. These are defined at national level.

In France, ASN has published a guide concerning applications for shipment approval, package design approval, or transport on the public road of radioactive material for civil uses. This "applicant's guide" presents ASN's recommendations to the applicants in order to facilitate the examination of approval applications and shipment approval requests for the transport of radioactive material. It also specifies the conditions of submission of the safety analysis reports to ASN and IRSN, their structure, the content of the draft approval certificate, the minimum processing times, the lessons learned from previous assessments and the measures to comply with in the event of a change of package design or material.

ASN revised this guide in 2012. The new version takes up points of doctrine that in the past were disseminated as circular letters and groups the information in a single document. Several new elements have been introduced. One is the creation of an appendix recapitulating the main requirements and safety standards used as references by ASN when examining the approval applications (accelerations values to consider for the stowage of packages, rates of release of fission gases from spent fuels to be considered in the safety justifications, consideration of the deferred impact of the content in a drop test, etc.). This appendix is intended to be updated each time the guide is revised, which ASN would now like to be done annually.

The second change concerns the examination process when a new package design approval application is made. The newly formalised process provides for stopping points (safety options file, test programme, safety analysis report) between the applicant, ASN, and IRSN - its technical support organisation, in order to identify as early as possible any shortcomings in the safety demonstrations that necessitate substantial additional inputs from the applicants, possibly even design changes. Out of concern for efficiency and control of schedules, as well as to ensure that the various applications are assessed in the same manner, it seems important to indicate the required documents and to formalise ASN's follow-up to the assessment of the safety analysis report.

### 8.2. A doctrine constantly being built upon

Some generic technical subjects are currently being discussed, such as the accelerations to consider for package retention system design, brittle fracture, etc. Answering these various questions is not one of the objectives of this report. ASN proposes that a regular assessment of progress on these subjects be made at the meetings of the Advisory Committee of Experts on transport once the doctrine has been stabilised.

## 9. EMERGENCY SITUATIONS

### 9.1. Transport event management plans

Paragraph 1.4.1.1 of the ADR provides that "*those involved in the transport of hazardous goods must take steps appropriate to the nature and scale of the foreseeable hazards, in order to avoid damage and, as applicable, to mitigate their effects*". In past inspections, the ASN inspectors have observed that the required appropriate measures planned for by the entities involved (consignors and carriers) were insufficient if not inexistent. Consequently, in 2004 ASN demanded in writing that the licensees submit "all the measures they plan implementing to manage a transport accident involving radioactive material and in particular their emergency plan dedicated to this purpose". This demand was clarified in 2005 by a letter in which ASN indicated the minimum content the Authority wished to see in the emergency procedures.

The emergency plan was thoroughly examined during ASN's inspections in the following years. As these inspections revealed persistent shortcomings, ASN decided to produce a guide to help the consignors establish an emergency plan. This guide relative to the content of the "plans for managing radioactive material transport events", currently at the draft stage, is intended for consignors of radioactive material packages transported by roads or rails. It describes the main elements to be included in such a plan. It more particularly requires the setting up of a robust pre-determined organisation for rapidly recovering packages involved in accidents and transferring them to a temporary storage site pending return to a normal situation.

ASN is also preparing a guide concerning the content of the emergency plans involving sealed sources of high activity - SSHAs (constituting one of the documents of the justification file to be provided when applying for authorisation to hold SSHAs). This guide will be intended for, among others, users of gamma ray projectors and Gamma knife sources and will include their transport in the context of their activity.

### 9.2. Exercises

#### 9.2.1. National emergency exercises

National exercises involving radioactive material transport are organised about once a year. The exercises mobilise the emergency organisation that would be deployed by the public authorities, the consignor and the carrier in the event of a radioactive material transport accident, in order to evaluate the coordination between the operators, the consistency and effectiveness of the actions implemented and the intervention capabilities in the field.

On the basis of a fictitious accident scenario affecting a transport operation unknown to the participants, the exercise must lead the operators concerned by safety and civil protection to:

- understand the state of the accident-damaged radioactive material shipment, predict how it will evolve and restore a satisfactory state of safety as quickly as possible;
- assess the nature and extent of the actual or potential radioactive releases, limit their quantity and determine the health impact for the population in the vicinity of the accident;
- implement the population protection measures;
- propose a package recovery plan if applicable.

Media pressure can also be simulated by having journalists present.

The exercises are organised in priority in the French départements that do not have nuclear installations and do not have the "nuclear culture" that naturally results from the proximity of such a facility. To give an example, in 2010 an exercise held in the Lot et Garonne département simulated a road accident between two heavy goods vehicles, one of which was transporting packages containing uranium dioxide powder, with the outbreak of fire.

The experience feedback from the various exercises allowed the following difficulties and lines for improvement to be identified:

- it is not always easy to rapidly determine the risks associated with a consignment: the placards identifying the load may be illegible in case of fire, and the documentation destroyed. It may be long and complicated to move back up the line to the carrier and the consignor to obtain the information essential for management of the accident;
- unlike the populations who live within the alert perimeter of nuclear facilities, the populations and media around the site of the accident have generally not been made aware of the nuclear risk and do not know the principles of sheltering and listening for instructions. There are no alerting systems either. Straight forward evacuation seems the most appropriate solution given the small number of people affected;

- it can take a long time to obtain reliable information and get the appropriate expertise to the accident site, a time that is sometimes incompatible with the need to take the initial decisions, obliging people to act "blindly" during the first hours following the accident. It would be worthwhile identifying the existing imaging resources (held by the GIE Intra and the Gendarmerie in particular), complementary to those of the national emergency organisation, and which could improve the transmission of information.

The public authorities have started giving thought to the management of RMT (Radioactive Material Transport) accidents as part of the studies on the management of radiological emergency situations further to the Fukushima accident.

### 9.2.2. Local exercises

The frequency with which national exercises are organised does not enable all the French prefectures to participate in them regularly. In 2008, ASN, IRSN and the MARN (Nuclear Risk Management Aid Committee) of the DGSCGC (General Directorate for Civil Protection and Emergency Preparedness) began a system of "turnkey exercises" to enable the prefectures that so wished to train themselves in the management of an accident involving a shipment of radioactive material. This system comes as a "kit" comprising two accident scenarios and an exercise guide. In parallel with this, the ASN divisions have actively participated in training the prefectures' services in how to respond to the radiological risk.

The aim of these exercises is to enable the prefectures, without the participation of the national emergency centres, to train for the first hours of local management of an accident involving a package of radioactive material and to test:

- the alert;
- the initial transmission of information;
- implementation of the reflex actions;
- the decision-making process leading to activation of the RMT ORSEC (National Emergency Response Plan).

Various turnkey exercises have been carried out. Other types of local exercises involving radioactive material transport have also been organised by licensees and prefectures. The small amount of experience feedback from these exercises has nevertheless revealed the following points:

- the importance of organising such exercises, particularly to give the various protagonists an introduction to the issues involved;
- the need to introduce educational material to help understand the radiological risk in prefectures that are not used to dealing with such risks.

⇒ *As organising national exercises is long and difficult, the organising of complementary "local" exercises is a very good practice. ASN encourages the different operators in radioactive material transport to support the organisation of these exercises.*

⇒ *Ensure closer national monitoring of the local exercises by ASN in order to better integrate the experience feedback.*

## **10. CONCLUSION**

ASN has assessed the safety situation of the transport of radioactive material for civil use in France based on the inspections carried out and the events notified by the consignors and carriers between 2007 and 2011. This assessment has revealed the information given below.

Given the large number of packages transported, representing some 900,000 packages each year, ASN estimates that on the whole the level of safety of radioactive material transport operations in France is satisfactory. It has nevertheless identified several lines for improvement in the basic nuclear installations, small-scale nuclear activities and the transport companies.

ASN considers that application of the requirements of the regulations and of the package design safety analysis reports needs to be improved, particularly for the packages subject to approval by the authority. The procedures and operating methods must comply with these requirements at all stages of the package life cycle, from design through to package preparation and carriage. Particular attention must be paid to application of the manufacturing specifications and of the user's and maintenance manuals. The organisational, human and material means necessary for the correct application of these requirements at all stages of the package life cycle must be sufficiently and correctly implemented. The implementation of procedures and appropriate ergonomic tools for limiting the risk of human error needs to be reinforced, as do the ergonomics of the documents used.

The organisation of transport operations must plan for monitoring of subcontractors so that the licensee can ensure that the operations they perform, or that the goods or services they supply (e.g. packagings), strictly comply with the specified requirements.

The conformity with the regulations of packages that are not subject to ASN approval needs to be improved. ASN still finds that the entities concerned (designer, manufacturer, distributor, owner, user, etc.) display shortcomings in the elements for demonstrating package conformity with the regulations, even if the situation is improving thanks to enhanced awareness on their part.

ASN observes that in the small-scale nuclear activities, the consignors are sometimes unaware that they are protagonists in the transport of radioactive material. During the inspections, many of them were unable to give the inspectors proof of shipment conformity with the regulations, particularly in the medical field and in the production of low level radioactive waste ("small waste producers").

ASN notes that the carriers still have an insufficient "radiation protection culture", particularly with the carriers of packages for medical uses and with certain air and maritime transport carriers who are unaccustomed to handling radioactive packages. The low frequency of vehicle contamination inspections, the insufficiency (or absence) of radiological protection programmes, the failure to wear dosimeters in airport environments and the inadequate securing of packages are deviations frequently observed by the inspectors. The system of carrier notification and authorisation planned for in the near future should enable ASN to better identify the transport companies operating in France and to improve both its oversight and its communication and educational actions through more exhaustive identification of the protagonists concerned. It will also allow the reinforcing of the regulatory requirement that companies transporting radioactive material designate a PCR (Person Competent in Radiation protection). The input of the PCR could enable carriers to optimise their practices in terms of radiation protection.

Generally speaking, the transmission of information and sharing of experience feedback - although improving - are still insufficient and must be the subject of constant effort. Transmission of information and experience feedback must not be limited to notable and significant events notified to ASN, but include early warning signs.

Lastly, the preparation for emergency situations through "local" exercises is a good practice that ASN encourages given the difficulties in organising emergency exercises on the national scale.

In order to enhance the safety of radioactive material transport operations in France, ASN has identified 11 lines for improvement listed in section 11 below.

## 11. PROPOSED LINES FOR IMPROVEMENT

<b><u>Improve the way organisational and human factors (OHF) are taken into account</u></b>	
1	The integration of organisational and human factors at each stage of the transport process is to be reinforced. The necessary organisational and human resources must be put in place to ensure the conformity of the safety analysis report and its application in the operating procedures. Means must also be provided to include the consignor in the transport process as early as possible, as soon as the approval application is submitted.
<b><u>Reinforcing and widening training measures</u></b>	
2	Operator training must be reinforced. The training must include a course on the stowage and tie-down of packages.
<b><u>Improving the ergonomics of the tools and documents</u></b>	
3	The consignors should improve the ergonomics of the radioactive material transport documents, notably by indicating directly on the transport document the measured values and the associated regulatory values or criteria. The applicants and the authority could also undertake a reflection on the ergonomics of the approval certificates.
4	The implementation of appropriate tools for ensuring the presence of plugs or caps, the tightening of the screws, limiting the possibility of objects falling into the packagings and, more generally, limiting the risks of human error during package preparation, are to be encouraged.
<b><u>Improving experience feedback on the use and maintenance of packagings</u></b>	
5	The applicants must improve their follow-up of the modifications in the package design, particularly when they are not the designers or owners of the packagings, in order to ensure that they have all the information liable to have an impact on the safety of transport of the package. Communication and sharing of experience feedback concerning the use and maintenance of packagings must be improved between all the protagonists (applicant, consignor, packaging owner and competent authorities).
6	Packaging maintenance is one of the important lines of the defence in depth system guaranteeing the safety of transport operations. Applicants shall provide the experience feedback from the use and maintenance of the packagings with any approval extension application. This experience feedback shall be studied as part of the application review.
<b><u>Reinforcing monitoring</u></b>	
7	Any transport operator must reinforce the monitoring of its subcontractors in order to ensure that the operations they perform, or that the goods or services they supply, comply with the specified requirements; This monitoring can be proportionate to the safety significance of the activities carried out. It must be documented and exercised by persons with the necessary skills and qualifications.
<b><u>Optimising radiation protection</u></b>	
8	The entities involved in the transport of radiopharmaceutical packages should undertake a common approach to the optimisation of radiation protection of operators at all stages of the transport process. This approach must include reflection on the organisation of deliveries, on the loading plans, on the measures planned during in-transit storage and in the transport hubs and on package conditioning and the loading plan at shipment (for example: loading that avoids complete unloading and reloading of all the packages at each hub).
9	Healthcare facilities must reinforce the measures in place to guarantee compliance with the regulations applicable to radioactive material transport. More particularly, personnel training must be improved and package shipment procedures drawn up or supplemented to guarantee compliance with all the applicable regulatory requirements.
<b><u>Preparing for emergency situations</u></b>	
10	Given that organising national exercises is a long and difficult task, the organising of complementary "local" exercises is a very good practice. ASN encourages the different operators in radioactive material transport to support the organisation of these exercises.
11	Ensure closer national monitoring of the local exercises by ASN in order to better integrate the experience feedback.

## 12. REFERENCES

- [1] Order of 9th December 2010 amending the order of 29<sup>th</sup> May 2009 concerning the land transport of dangerous goods (called the "TMD order").
- [2] ASN Guide of 21<sup>st</sup> October 2005 to the conditions of notification and codification of criteria related to significant safety, radiation protection or environmental events applicable to basic nuclear installations and radioactive material transport operations

## 13. GLOSSARY

Transport package	A whole comprising the content (fuel, waste, radionuclides, etc.) and the packaging.
NPP	Nuclear Power Plant
TSA	Transport Safety Advisor
DEMUR	Radioactive Material Dispatch Note (document accompanying the package during transport)
DGAC	French General Directorate of Civil Aviation
Significant events	Incidents or accidents of particular significance, particularly in terms of actual or potential consequences on the workers, the public, the patients or the environment
Notable events	Deviations that have no impact on transport safety. These events are not classified on the INES scale.
OHF	Organisational and Human Factors
BNI	Basic Nuclear Installation. Installation which, due to its nature or the quantity or activity of the radioactive material it contains, is subject to the Act of 13 <sup>th</sup> June 2006 (TSN Act). These installations must be authorised by decree further to a public inquiry and the opinion of ASN. Their design, construction, operation (both when functioning and when shut down) and decommissioning are regulated.
IRSN	French Institute for Radiation Protection and Nuclear Safety
Small-scale nuclear activities	This category groups many domains that use ionising radiation, such as medicine (radiology, radiotherapy, nuclear medicine), human biology, research and industry, but also certain veterinary, forensic medicine and food conservation applications.
PCR	Person Competent in Radiation protection
REX	Experience feedback
SSHA	Sealed Sources - High Activity
Own-account transport	Own-account transport is established when the goods are the property of the company or have been sold, purchased, hired, produced, extracted, transformed or repaired by the company and are transported by that company for its own purposes using its own vehicles and drivers or vehicles hired with or without a driver; transport must remain an ancillary activity for the company.

## **ANNEXE 1 : RADIOACTIVE MATERIAL TRANSPORT MOVEMENTS IN FRANCE**

In 2006 IRSN estimated that about 900,000 packages of radioactive material are transported each year in France, which represents about 6% of the total number of dangerous goods packages transported each year in France.

The nuclear industry represents about 15% of the annual radioactive material transports, while 85% of the transported packages are intended for the health, non-nuclear industries or research sectors, referred to as small-scale nuclear activities, of which about 30% is accounted for by the medical sector alone.

The fuel cycle necessitates an estimated annual total of 11,000 transports involving 141,000 packages. These include approximately:

- 1,000 transports from or to foreign countries or transiting via France, representing about 50,000 packages;
- 300 transports of fresh uranium-based fuel and some 30 transports of fresh uranium and plutonium-based "MOX" fuel;
- 200 transports of spent fuel transported from the EDF NPPs to the La Hague reprocessing plant operated by Areva;
- about 60 transports of plutonium in oxide form transported from the La Hague reprocessing plant to the MELOX fuel production plant;
- 250 transports of uranium hexafluoride necessary for the fuel manufacturing cycle.

The field of nuclear industry research, which essentially concerns the CEA, accounts for a little less than 3,000 transports per year transporting about 8,000 packages.

The majority of these transports are transported by road, but transports are also made by rail, sea, air or multimodal transport (see figure 13).

<b>Approximate number of packages and shipments</b>		<b>Rail</b>	<b>Sea</b>	<b>Sea and rail</b>	<b>Road</b>	<b>Road and air</b>	<b>Road and rail</b>	<b>Road and sea</b>
Packages approved by ASN	Number of packages	20		50	90,000	150	130	1,000
	Number of shipments	20		415	58,000	70	110	20
Packages not requiring approval by ASN	Number of packages	3,900	20	21,300	760,000	45,000	1,400	14,200
	Number of shipments	30	20	100	542,000	14,000	460	280

**Figure 12 : Breakdown of radioactive material transports by mode of transport**

## **ANNEXE 2 : PRESENCE OF FOREIGN OBJECTS IN PACKAGES**

Several events concerning the discovering of foreign items in type-B packages used for transporting fresh or spent fuel assemblies have been notified in the last few years. These events were rated level 0 on the INES scale or below it, as the presence of these foreign objects had no consequences during the transport operations.

Nevertheless, according to IRSN, the presence of hydrogenated foreign objects in the packagings could lead to an increase in the internal pressure due to their possible breakdown under the effect of the radiation (radiolysis or thermolysis phenomena), or even induce risks of explosion due to the production of inflammable gases.

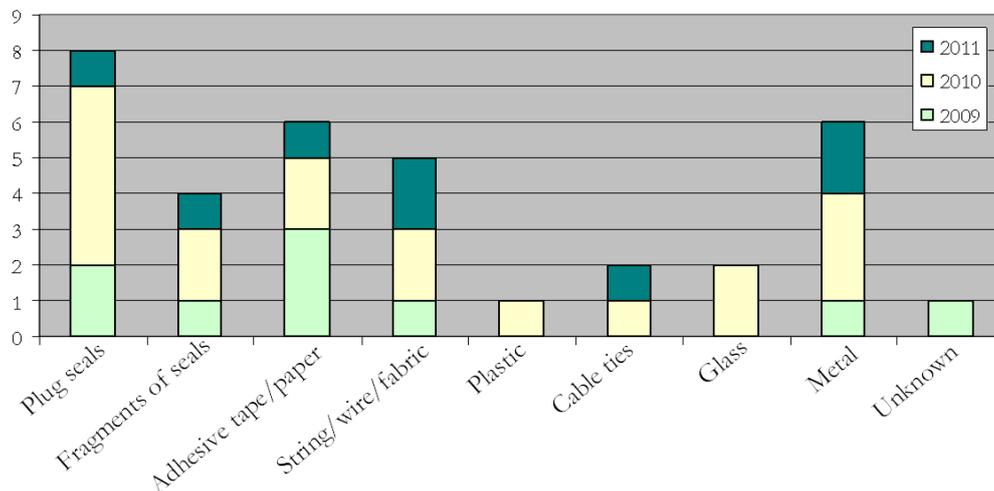
At the request of ASN in 2009, the companies AREVA NC, TN International, EDF and MELOX met in a working group in 2010 in order to identify the origin of the foreign objects found in the cavities of the packagings and to improve the control of the cleanliness of the cavities of packagings used to transport spent fuel and fresh MOX.

This working group sent ASN a joint summary notice listing all the commitments taken by each entity. These commitments more specifically consist in:

- performing visual inspections on the AREVA and EDF sites to verify the cleanliness of the packaging cavities;
- the cleanliness of the facilities and work areas (FME [Foreign Material Exclusion] approach, 5S approach, removal of objects that could fall into the packaging);
- work organisation (for example: minimising the time for which the cavity remains open)

Besides this, representative gaseous samples were taken from May 2009 through to the end of 2010 from the cavities of TN12/2, TN13/2 and TN 112 packagings on the AREVA NC La Hague site. All the analysis reports sent to ASN reveal measured hydrogen levels below the lower flammability limit (LFL) for each package design

Diverse types of foreign objects are found in the packaging cavities, associated with different activities (operation, maintenance, etc.), the design (seals) or the facilities (ropes, adhesive tape, flakes of paint, etc.). The number of discoveries of foreign objects in packaging cavities listed by this inter-licensee working group and the nature of the foreign objects are shown in figure 14 (results as at 28th March 2011).



**Figure 13 : Discovery of foreign objects in packaging cavities between 2009 and 2011 (figures provided by the inter-licensee working group)**

Moreover, the repeated discovery of orifice seals in the cavity of packagings confirmed the high risk of these seals being sucked in when the orifices are opened. These findings have led to revising of the packaging utilisation procedures and a change in the design of these orifices on the packagings:

- The installation of specific tools: placing the tool connecting with plug orifice at negative pressure with respect to the cavity when the plug is opened for the first time;
- Change in the design of the plugs of TN 12/2 and TN 13/2 packagings having formed the subject of an approval extension: change to a trapezoidal-shaped groove guaranteeing retention of the seal in its groove irrespective of the pressures upstream and downstream of the seal. The modified packagings should be used in the EDF NPPs in early 2013. ASN has asked that this modification be extended to the TN 17/2 packagings.

As maintenance of these packagings is scheduled for every 15 transport cycles or every 3 years, the effectiveness of the measures put in place has not yet been assessed. ASN has asked the working group to choose two control packagings (one TN 12/2 and one TN 13/2) which must be used more frequently than usual in order to speed up their return for maintenance and enable the effectiveness of the measures adopted by the working group to be evaluated.

### **ANNEXE 3 : INCIDENT NOTIFICATIONS FOR EVENTS PRESENTED IN THE REPORT AND RATED LEVEL 1 OR HIGHER ON THE INES SCALE**

#### **1. Incident in the transport of a radioactive material package at the end of 2001: irradiation of a second employee of the company FedEx** (*incident rated level 3, 2002*)

On 7<sup>th</sup> January, ASN was informed by the American and Swedish safety authorities and by the Roissy branch of the company Federal Express (FedEx), of a radioactive material transport incident involving a package whose dose rate was abnormally high.

On delivery of the package to New Orleans on 2<sup>nd</sup> January, the consignee had detected an abnormally high dose rate and had informed the American nuclear safety authority. The dose rate on one side of the package attained 4 millisieverts per hour at a distance of 25 metres and on the other side 0.01 millisievert per hour at a distance of 5 metres.

Medical examinations of the FedEx employees at Roissy revealed that two of them had been irradiated, one reportedly having received a dose of about 100 millisieverts. There is a very strong presumption, but without absolute certainty, that the package which transited via Roissy in December was the source of this irradiation.

ASN asked FedEx to carry out a study of the work stations of its personnel that could handle packages of radioactive material and to apply the ALARA optimisation method to reduce the doses likely to be received by its personnel.

The Swedish nuclear authority rated this incident level 3 on the INES scale due to the deficiency in protection against radiation.

#### **2. Radioactive material transport incident at Roissy** (*Level 1 incident, 2002*)

A radioactive material transport incident occurred on 17<sup>th</sup> August 2002 at the Roissy Charles-de-Gaulle Airport (Val d'Oise département). A road section in a reserved zone of the airport site was contaminated following the falling and crushing of a radioactive material transport package.

The package fell from the truck that was carrying it from the warehouse of the company France Handling to the aircraft. After it fell, the package was in all likelihood crushed by the following vehicles, causing rupture of containment and dispersion the radioactive material on the road.

The airport fire-fighting service, the air transport gendarmerie, the Paris Fire Brigade and the intervention unit from CEA Saclay accompanied by the company CIS Bio international (radiopharmaceutical producer) intervened rapidly. ASN was alerted and monitored the securing of the zone. A safety perimeter was established around the contaminated zone. The identified contamination stains were fixed with paint and covered with tarpaulins. The presence of vehicles in this zone was prohibited.

On 19<sup>th</sup> August ASN carried out an unannounced reactive inspection at Roissy airport. With the technical support of IRSN (Institute of Radiation Protection and Nuclear Safety), the contaminated zone was subject to an in-depth examination, enabling the contamination to be mapped and various solutions for restoring a normal situation to be considered. The radiological measurements confirm the presence of contamination stains and highlight several very localised points of contamination. This contamination leads to a radiation intensity of about ten microsieverts per hour at 50 cm from the contamination points, which does not represent a health risk for workers who do not stay any length of time in this zone.

Furthermore, the inspection enabled the personnel having intervened during the incident to be identified in order to verify their non-contamination. The medical examinations of the gendarmes who had intervened revealed very slight contamination, with no consequences on their health.

Lastly, the inspectors visited the premises of France Handling to check the conditions of handling and stowage of packages transiting in their warehouses and to examine the radiation protection training programmes. The packages

are transported to the aircraft in a container by a trailer truck. It seems that the package that fell was poorly wedged and poorly tied-down in this container.

The package shipped by CIS Bio international to Croatia contained 5 GBq of iodine 131. The radioactive material was in powder form in a gelatine capsule. The packaging consisted of a glass flask placed in a lead pot protecting against radiation, and this pot was itself placed in a metal box with a crimped cover. This box was packed in a cardboard box and wedged by cardboard and polystyrene. This radionuclide is used in nuclear medicine to treat thyroid cancer. Its half-life is very short: the radioactivity of iodine 131 decreases by half in 8 days.

Due to the loss of the radioactive material containment, ASN rated this event **level 1** on the **INES** scale.

### 3. Traffic accident in the Marne département (*incident occurring in 2007*)

ASN was informed in April 2007 of a traffic accident involving a vehicle transporting a radioactive package. This accident occurred at around 6h30 on the national highway No. 4 between Paris and Nancy, near the commune of Fère-Champenoise (Marne département).

A van belonging to a German cosmetics company that was transporting a radioactive package collided with a heavy goods vehicle. The van was completely burnt out and the two drivers died in the accident.

At the request of the Marne Prefecture, the firemen from the CMIR (mobile radiological intervention unit) of Châlons-en-Champagne went to the accident site to take the first radiological measurements. The CMIR installed a 30-metre safety perimeter around the van. The witnesses of the accident who were close to the van were taken charge of by the CMIR.

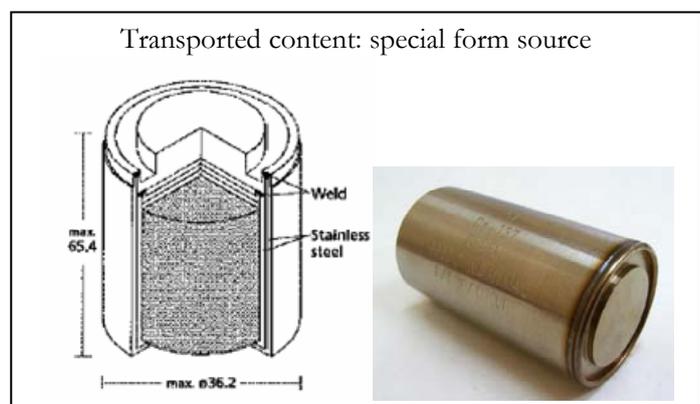
The ASN mobilised its emergency centre to assist the local authorities. The ASN division of Châlons-en-Champagne went to the accident site to assess the situation.

IRSN also went to the site to take measurements. The inspections carried out by IRSN showed that the package had only suffered superficial damage. No trace of contamination was detected on the persons present. The on-site measurements also showed the absence of contamination.

The complementary investigations conducted by ASN revealed that the package contained a high-activity sealed source (81.4 TBq) which was to be used in an irradiator of the Henri Becquerel national laboratory operated by the CEA.

ASN called upon its technical support organisation IRSN to transport the package to the CEA Saclay site. It also asked IRSN to carry out inspections of the package and the radioactive source to decide whether it could be reused or had to be disposed of as radioactive waste.

ASN demobilised its emergency organisation once the package was placed in security.



#### **4. Falling of a type-B package during unloading** *(level 1 incident, 2007)*

On 10<sup>th</sup> October 2007, when unloading a truck using a fork-lift truck and a handling trolley outside the facility, a type B(U) package fell a distance of 1m20. The package retained its leak-tightness and the event had no consequences on the personnel.

The initial analysis of the event showed that the package approval certificate and the facility's baseline safety requirements provided for unloading using the handling eyes provided on the package. These methods were not applied during the operation. Furthermore, the persons doing the handling did not have a user's manual for the packaging.

The licensee was able to transfer the package to the facility's material access chamber in order to put it back in the normal position using the approved handling means. The licensee then took the content out of the package, by transferring it to one of the facility's shielded lines. Complementary examinations were planned to check that the transport package could be reused.

Due to the noncompliance with the transport conditions and noncompliance with the facility's baseline safety requirements, the licensee rated the event **level 1** on the INES scale.

the event took place in ATALANTE. This facility is used to perform radiochemical analyses (chemistry in radioactive environment carried out in glove boxes or in shielded process lines), on active fuels, in the context of research into the reprocessing of spent fuels, from their dissolution through to vitrification.

#### **5. Deterioration of the shock absorber system on a packaging design** *(level 1 Incident, 2009)*

On 24<sup>th</sup> April 2009 ASN was informed by the CEA of a generic anomaly on a type of packaging for transporting radioactive material.

An inspection of the conformity of packagings of type TN-BGC with the applicable baseline safety requirements, revealed deterioration of part of the wood of the shock-absorbers and levels of humidity exceeding the safety analysis report specifications.

The abnormal humidity is in all likelihood due to the storage - no doubt for a considerable time - of the packagings, outside the buildings in unfavourable weather conditions. It concerned about a third of the total number of packagings, that is to say a few dozen TN BGC packagings.

This deterioration had no consequences on the personnel or the environment. However, this deviation from the baseline safety requirements could have affected the safety of the packages in the event of an accident.

The CEA, in agreement with ASN, immediately suspended transports using the packages concerned. A first batch of twenty packagings was inspected and reconditioned for transport operations. The remainder of the pool was then checked and reconditioned. The packaging shock absorbers are now always welded to prevent any infiltration of humidity.

Although the detected anomaly caused no immediate danger to the environment or people, its "generic" nature led ASN to rate the event level 1 on the INES scale.

These packagings are used to transport non-irradiated nuclear material such as uranyl powder, metallic uranium or fuel.

## **6. Noncompliance with the authorisation conditions for transporting fresh fuel (level 1 incident, 2011)**

On 21<sup>st</sup> November 2011 ASN received notification from the Civaux NPP of a significant event involving the picking up - by error - of a trailer loaded with four fresh fuel packages.

ASN carried out an inspection on 12<sup>th</sup> December 2011 to analyse the circumstances of this event.

On Wednesday 16<sup>th</sup> November 2011, at about 21h00, drivers from a subcontractor of TN International (AREVA group) came to collect two empty transport trailers from the Civaux NPP site. Their mission was to take these empty trailers to another nuclear site. An error in the identification of the trailers led them to pick up a trailer loaded with four fresh fuel transport packages instead of an unloaded trailer.

Before they reached the public road, the driver of the loaded trailer realised that it was loaded. He then took the transport vehicle back to its initial parking area to notify the event.

The inspection conducted by ASN showed that:

- the instructions and inspection procedures applicable to the picking up of transport trailers on the NPP were not respected;
- the verifications of transport operations were found to be ineffective;
- during the transport of the loaded trailer, the conditions of transport of the fresh fuel packages, particularly as regards the stowage of the packages, were not compliant. The on-vehicle documentation normally required for such a shipment to describe the transported material was absent, given that the driver was supposed to be transporting an empty trailer.

The ASN-approved packages are designed to withstand accident situations and the package would have ensured the safety of transport, including in the event of an accident, if the shipment had gone onto the public road. Nevertheless, due to the noncompliance with the transport conditions for fresh fuel packages, the licensee proposed rating the significant event at **level 1** on the **INES** scale, which has 7 levels.

The licensee must moreover submit to ASN the significant corrective actions concerning the organisation of radioactive material transport at the Civaux NPP, to take into account the lessons learned from this event.

## **7. Noncompliance with the regulatory dose rate on a spent fuel shipment (level 1 incident, 2012)**

A consignment of spent fuel shipped on 27<sup>th</sup> December 2011 by the Blayais NPP displayed a dose rate exceeding the regulatory level at a distance of 2 metres from the surface of the vehicle.

The regulations applicable to road and rail transport radioactive material stipulates that the radiation intensity under routine transport conditions must not exceed 0.1 mSv/h at a distance of 2 metres from the external surface of the vehicle or wagon.

On 27<sup>th</sup> December 2011, the Blayais NPP shipped a consignment of spent fuel. The first part of the journey was carried out by road to reach the railway network junction situated several kilometres from the nuclear power plant. The checks performed prior to train departure revealed radiation intensity at one measuring point of 0.13 mSv/h at 2 metres from the wagon. The package was immediately redirected to the site.

The licensee's first investigations revealed that the checks performed on departure from the site had indeed detected this dose rate exceeding the regulatory criterion. However, this deviation was not identified by EDF before the road convoy shipment was made.

ASN carried out an inspection on 13<sup>th</sup> January 2012 to analyse the circumstances of this event and asked the licensee to perform a detailed analysis of the organisational and human factors underlying this event and to take measures to ensure that it could not happen again.

The dosimetric measurements of the personnel that worked on this shipment did not evidence any exceeding of the forecast doses. The doses received remain within the average for the doses normally expected with this type of shipment.

Due to the absence of public exposure and the low level of exposure of the workers involved, this event had no real consequences on the personnel, the environment or the safety of the installation. Nevertheless, in view of the

noncompliance with the regulatory provisions concerning the transport of radioactive material, this event was rated **level 1** on the **INES** scale.

### 8. Failure on a package containing uranium hexafluoride - AREVA (level 1 incident, 2012)

On 25th March 2011, ASN was notified ASN of an event concerning deficiencies in the closing system of the protective overpacks used to transport cylinders of uranium hexafluoride (UF<sub>6</sub>), enriched or not.

Uranium hexafluoride, which is used to manufacture nuclear fuel for the nuclear power plants, is transported on the public road in a cylinder that ensures the containment of the material. The cylinder is placed in a protective overpack. The incident concerned a "UX-30" overpack, which comprises two half-shells joined together by 10 "ball-lock pins" (see photos) and two closing bands.

The incident involved the disengagement of some of the ball-lock pins during transport due to their unexpected release. The additional mechanism comprising the two arch-shaped bands for closing the two half-shells guarantees that there is no risk of the overpack opening during normal use of the transport package. On the other hand, in the event of a transport accident, the mechanical resistance of the overpack would be lower than initially planned for in the package design.

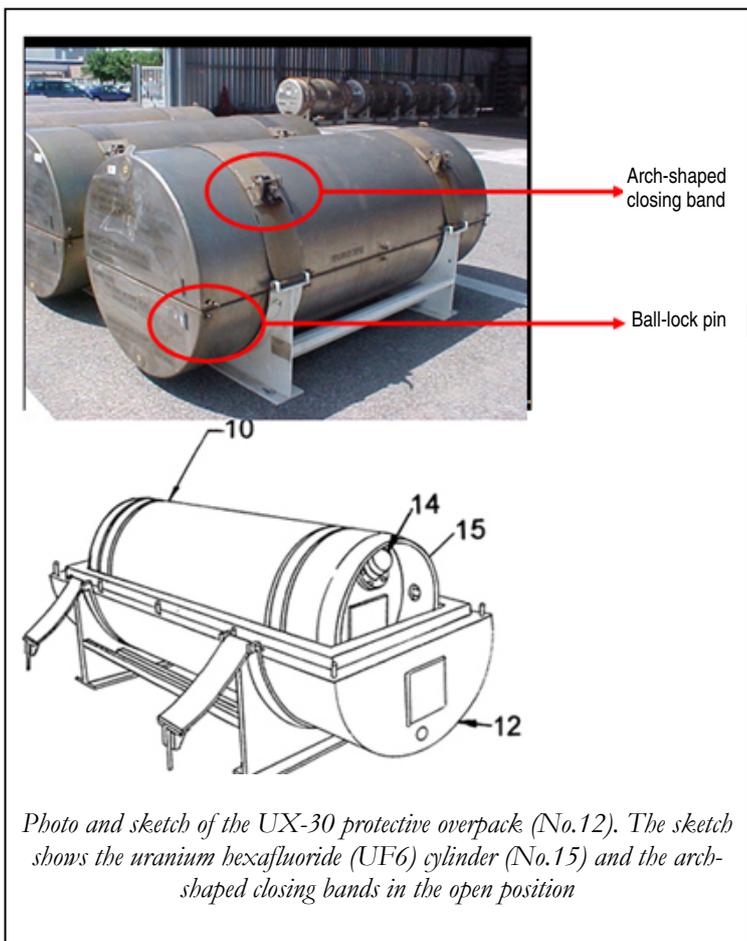
Disengagement of some ball-lock pins was observed three times by companies in the AREVA group in 2010 and 2011, and each time a significant event notification was made to ASN. The events were initially rated level 0 on the INES scale. The recurrent nature of this incident, and the investigation which showed that insufficient account had been taken of experience feedback within the AREVA group in the area of transport, led ASN to reclassify the event at **level 1** on the **INES** scale.

In a letter dated 1<sup>st</sup> April 2011, ASN instructed the AREVA group to conduct in-depth investigations into the reasons for the failings observed on the "UX-30" overpacks. ASN moreover carried out an inspection on 20<sup>th</sup> April 2011 within the AREVA NC Pierrelatte and EURODIF companies, both of which are consignors of this package design. The two follow-up letters are posted on the ASN web site.

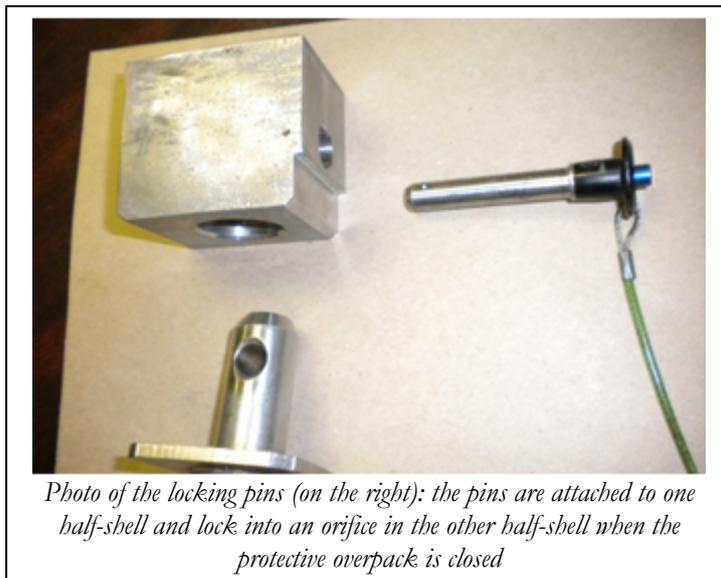
Examination of the event revealed that the American designer of the "UX-30" overpack had recommended, before the events occurred in France, the replacement of the current pins by pins of a different design that should improve their locking. This experience feedback in the United States had not been brought to the knowledge of AREVA.

The locking pins of all the UX-30 overpacks belonging to companies in the AREVA group are currently being replaced to integrate the American designer's recommendation.

Since April 2011, the AREVA group has undertaken to only put into circulation overpacks whose locking pins are equivalent to the recommended design. The pre-shipment inspections have moreover been reinforced.



ASN informed the American authorities (Department of Transport and Nuclear Regulatory Commission) of the occurrence of the events observed in France. It will also inform the European Association of Competent Authorities on the transport of radioactive material) (EACA) so that ASN's European counterparts can draw the same lessons.



## ANNEXE 4 :      TRANSAS MISSION IN FRANCE

In 2002, France asked the IAEA to assess its organisation of the transport of radioactive material and application of the international regulations. The subsequent TransSAS (Transport Safety Appraisal Service) mission ran from 29<sup>th</sup> March to 8<sup>th</sup> April 2004. The team that carried out the mission comprised fourteen experts from nine different countries (Germany, Canada, Egypt, the United States, the United Kingdom, Ireland, Japan, New Zealand and Panama) and included two experts and one technical writer from the IAEA.

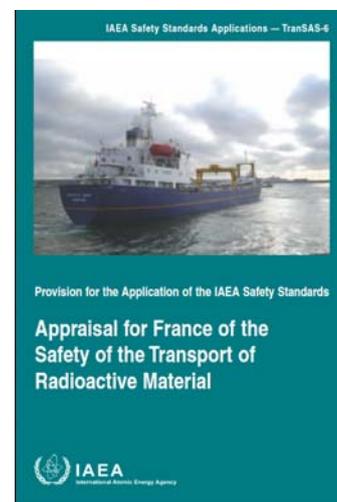
The mission's assessment report indicated three broad categories:

- recommendations on the areas in which ASN must bring improvements pursuant to the international regulations;
- suggestions concerning the areas in which ASN could improve its effectiveness;
- good practices which can serve as models for other competent authorities in the transport of radioactive material.

The report contains three recommendations, sixteen suggestions and twelve good practices. It concludes that the international regulations are applied in accordance with IAEA requirements and that improvements can be made, particularly with regard to the updating of the guides and procedures, and that it has formal proof that all the requirements are effectively satisfied. These conclusions can be consulted on:

[www.asn.fr/index.php/Les-actions-de-l-ASN/International/Organisations-internationales/Organisations-de-l-ONU/Les-audits-de-l-AIEA-en-France](http://www.asn.fr/index.php/Les-actions-de-l-ASN/International/Organisations-internationales/Organisations-de-l-ONU/Les-audits-de-l-AIEA-en-France)

The good practices noted by the TransSAS mission concern maritime transport and emergency situation preparedness in particular. A follow-up mission carried out in November 2006 found that the actions relative to all the recommendations and suggestions had either been completed or were well under way.





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