TRANSPORT OF RADIOACTIVE MATERIALS

CHAPTER 11

The Nuclear Safety Authority (ASN) has since 12 June 1997 been responsible for regulations pertaining to the safe transport of radioactive and fissile materials for civil use and for enforcement. Its role in this field was confirmed by law 2006-686 of 13 June 2006 on Transparency and Security in the Nuclear Field (TSN law) which instituted the Nuclear Safety Authority.

It should be noted that the radioactive material transport regulations have two separate objectives:
- security, or physical protection, consists in preventing loss, disappearance, theft and misuse of nuclear materials (usable for weapons), for which the Defence High Official attached to the Minister of the Economy, Finance and Industry is the responsible authority;
- for its part, safety consists in minimising the irradiation, contamination and criticality hazards involved in radioactive and fissile material transport, ensuring that man and the environment experience no ill effects. Monitoring safety is the responsibility of ASN.

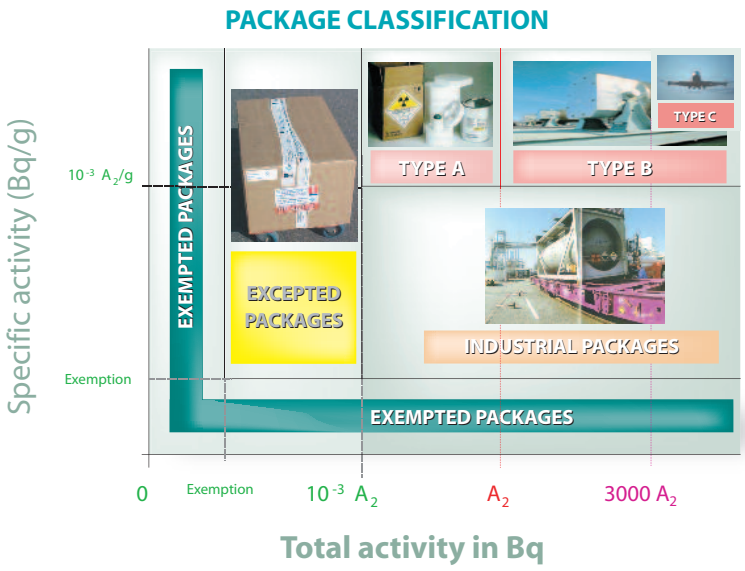
Pursuant to decree 2001-592 of 5 July 2001, regulation of the transport of radioactive and fissile materials for national security purposes falls to the Defence Nuclear Safety and Radiation Protection Delegate (DSND).

1 GENERAL INTRODUCTION

1 | 1

Packages

The term package designates the container with its radioactive contents ready for transport. The regulations define several types of package, depending on the characteristics of the substance to be transported, such as its total activity, its specific activity, its physico-chemical form and its fissile character where applicable. For each radionuclide, a reference activity level is defined, where the lowest levels correspond to the most noxious products. This value is called A1 for materials in a special form (guaranteeing no dispersion) and A2 in all other cases. For example, for Pu 239, A1 is equal to 10 TBq and A2 is equal to 10^{-3} TBq.



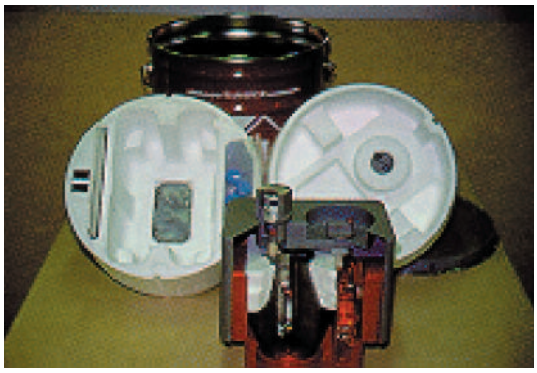
Type of package depending on total and specific activity

The adjoining diagram shows the different types of package defined by the regulations.
Packages fall into one of the following categories:
- excepted packages: very low activity of contents, below 10^{-3} A1 or 10^{-3} A2;
- industrial packages: low specific activity of contents, below 2.10^{-3} A1/g or 2.10^{-3} A2;
- type A packages: activity of contents below A1 or A2;
- type B packages: activity of contents above A1 or A2; and
- type C packages (air transport): activity of contents above 3000 A1 or 3000 A2.

This package classification only applies to the transport of materials having specific and total activities exceeding the exemption thresholds defined in the relevant transport

regulations. Packages where the specific or total activity levels are below the exemption thresholds are considered to be exempted.

Types A and B packages



Example of a type A packaging – Technetium 99 generator

Example of a type B packaging – Gammagraph containing an iridium source

Each type of package is governed by specific safety requirements and test criteria confirming the capacity of the package to withstand normal or accident transport conditions (see box below).

Characteristics of the various types of packages

Excepted packages are subjected to no qualification tests. However, they must comply with a number of general specifications, such as a maximum dose rate at the surface below 0.005 mSv/h. Non-fissile industrial or type A packages are not designed to withstand accident situations. However, they must withstand certain incidents which could occur during handling or storage operations. They must consequently withstand the following tests:
- exposure to a severe storm (rainfall reaching 5 cm/h for at least 1 hour);
- drop onto a rock target from a height varying according to the weight of the package (maximum 1.20 m);
- compression equivalent to 5 times the weight of the package; and
- penetration by dropping a standard bar onto the package from a height of 1 m.

These tests should give rise to no loss of material and radiation shielding deterioration must remain below 20%.

Fissile or type B packages must be designed so that they continue to fulfil their containment, sub-criticality and radiation shielding functions under accidental conditions. These accidents are represented by the following tests:
- a series of three consecutive tests:
  - a 9 m drop test onto a rock target,
  - a 1 m drop onto a spike,
  - encircling fire of at least 800 °C for 30 minutes; and
  - immersion in 15 m deep water for 8 h (200 m water depth for spent fuel).

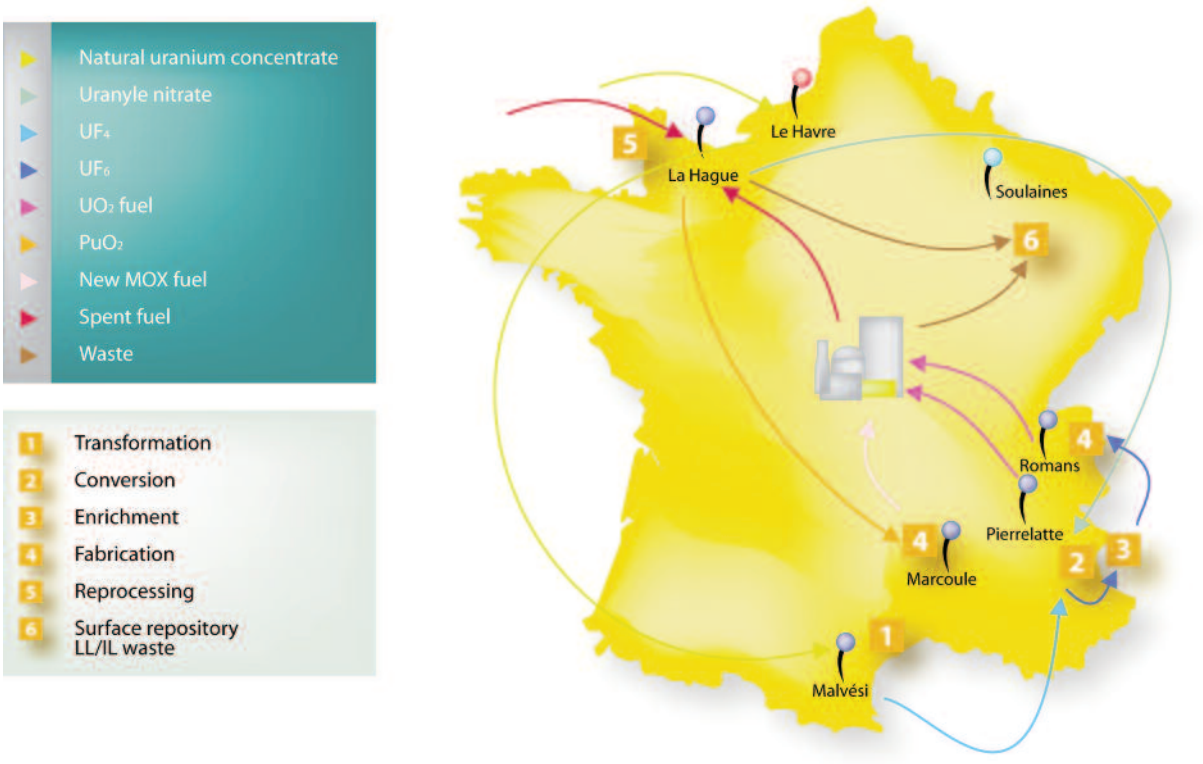
Type C packages must be designed so that they continue to fulfil their containment, sub criticality and radiation shielding functions under representative air transport accident conditions. These accidents are represented by the following tests:
- a series of three consecutive tests:
  - a 9 m drop test onto a rock target,
  - a 3 m drop onto a spike,
  - encircling fire of at least 800 °C for 60 minutes;
- 90m/s impact on a rock target; and
- immersion in 200 m deep water for 1 hour.

1 | 2

Annual traffic

Several hundred thousand radioactive material packages are transported in France annually, representing a few percent of the dangerous goods traffic. Most (two-thirds) consist of radioisotopes for medical, pharmaceutical or industrial use. The diversity of these packages is considerable. Their radioactivity varies by more than twelve orders of magnitude, or from a few thousand becquerels (pharmaceutical packages) to millions of billions of becquerels (spent fuel), and their weight from a few kilograms to about a hundred tons.

The nuclear power cycle industry gives rise to the transport of many sorts of radioactive materials: uranium concentrates, uranium tetrafluoride, depleted, natural or enriched uranium hexafluoride, fresh or spent fuel assemblies containing uranium oxide or mixed uranium and plutonium oxide (MOX), plutonium oxide, waste from power plants, reprocessing plants, CEA research centres, etc. The largest consignments concern about 300 shipments per year for fresh fuel, 250 for spent fuel, about 30 for MOX fuel and about 60 for plutonium oxide powder.



Transports related to the fuel cycle in France

Since transport provisions are international, France is also a transit country for some of these shipments, for instance for spent fuel packages from Switzerland or Germany, bound for Sellafield in Great Britain, which are taken on board ship at Dunkirk.

Spent fuel transport from Germany stopped at the end of June 2005 in compliance with the agreements between the government and the electricity utilities of this country.

1 | 3

Industrial participants

The main participants in transport arrangements are the consignor and the carrier. The consignor is responsible for package safety and accepts his responsibility by way of the dispatch note accompanying the package remitted to the carrier. Other participants are also involved: the package designer, manufacturer and owner and the carriage commission agent (authorised by the consignor to organise the transport operation).

For a radioactive material shipment to be carried out in good safety conditions, a stringent chain of responsibility has to be set up. So, for major transport operations:

- the consignor as nuclear licensee must be fully aware of the characteristics of the material to be transported, so that he can select packaging and specify transport conditions accordingly;
- the corresponding packaging must be designed and sized in accordance with conditions of use and current regulations. In most cases, a prototype is needed to carry out the tests prescribed by the regulations. Following this phase, the safety documents are prepared and submitted to the competent authority, to back up the authorisation application;
- in cases where existing containers are used, their conformity with approved models has to be confirmed. In this context, the container owner must set up a maintenance system in conformity with that described in the safety documents and the authorisation certificate;
- the container is sent to the consignor's site, where it will be loaded with the material for transport. The consignor must carry out the inspections for which it is responsible (leaktightness, dose rate, temperature, contamination) on the loaded container prior to entry on a public road or railway track;
- the transport operation itself is organised by the carriage commission agent, who is responsible for obtaining requisite permits and complying with advance notice requirements on behalf of the consignor. He also selects the means of transport, the carrier and the itinerary, in compliance with the above-listed requirements;
- the actual transport is entrusted to specialised firms, having the necessary permits and vehicles. The drivers of road vehicles in particular must be in possession of the training certificate required by the regulations.

1 | 4

Regulation of the safe transport of radioactive materials

In the context of regulation of the safe transport of radioactive and fissile materials, the Nuclear Safety Authority (ASN) is responsible for:

- defining technical regulations and supervising their enforcement;
- accomplishing authorisation procedures (approval of packages and organisations);
- organising and implementing inspection procedures;
- proposing and organising information of the public.

In addition, ASN acts within the context of emergency plans defined by the authorities to deal with an accident.

In a decision of 1 December 1998, the ministers responsible for nuclear safety set up an Advisory Committee for the transport of nuclear materials, on similar lines to those which already existed. Depending on the importance of the issue, expert assessment by the Institute for Radiation Protection and Nuclear Safety (IRSN), at ASN's request, could be supplemented by an Advisory Committee review.

2 ASSESSMENT OF SAFETY DOCUMENTS

ASN conducts a critical analysis of the safety documents proposed by the applicants to obtain an approval certificate for their package design.

Certain package designs require the approval of the competent authority before they can be authorised for transport in France:
- radioactive materials in special forms;
- slightly dispersible radioactive materials;
- type B and C packages and all fissile material packages;
- special arrangement shipments (the package fails to comply with all the requisite criteria, but compensatory transport measures have been taken to ensure that transport safety will not be below that of a transport operation involving an approved package).

By delegation from the ministers and after technical review of the documents by IRSN, ASN approves the package designs complying with the regulations and validates approvals issued by the competent authorities in other countries for transport in France.

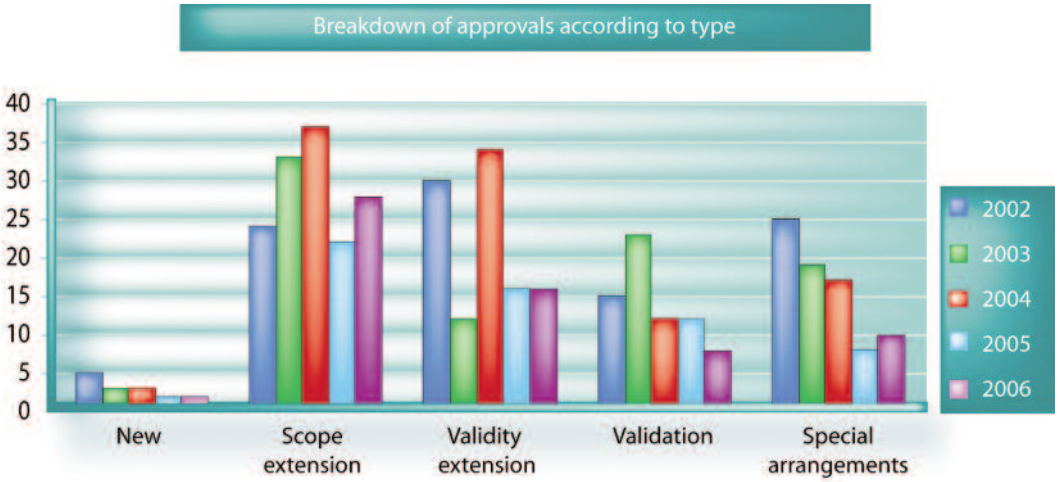
These certificates are usually issued for a period of a few years. At the present time, about 100 applications for approval are submitted annually by the manufacturers to ASN (new package design, extension of the term of validity, validation of a certificate issued by a foreign authority, special arrangement, extension of a certificate to cover contents other than those initially defined in the safety documents).

Generally speaking, certificates are issued for package designs and not package by package. However, manufacturing, operating and maintenance conditions are consistently specified.

These certificates are often issued outside the context of specific transport operations, for which no prior notification of ASN is generally required, but which may be subjected to security checks (physical protection of materials under the control of the Defence High Official at the Ministry for Industry).

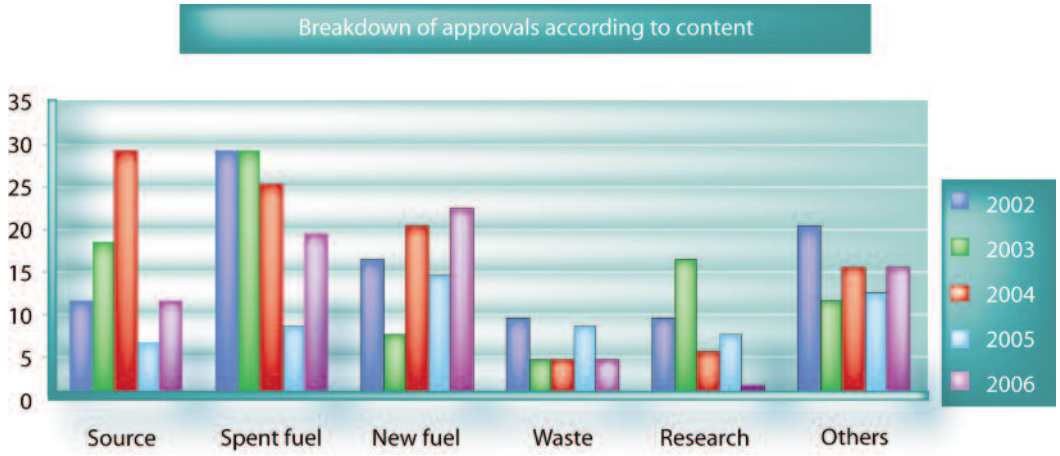
2 | 1 Issue of package designs approval certificates

In 2006, ASN issued 63 certificates, broken down as follows according to their type:



It is worth noting the significant reduction in special arrangements issued since 1999. This illustrates the effects of ASN actions in this field and the efforts made by the radioactive material transport industry.

The types of transport concerned by these certificates are as follows:



As a result of its 2006 examinations, ASN issued approval certificate F/391/B(U)F-96 (Aa) for the new IR 100 package model, designed to replace older concepts. This new package model was developed by the Commissariat à l'énergie atomique to transport fresh or spent fuel elements.

New IR100 packaging

In order to encourage replacement of the older packages, ASN decided in 2006 that packages in conformity with a model approved by the 1973 editions of IAEA's radioactive material transport regulations would no longer be authorised for use in France as of 31 December 2010. The approval or validation certificates issued by ASN will therefore expire no later than the end of 2010 for these older models.

During the 2006-2010 transitional period, the applicants will be required to develop new concepts or revise the safety documents to ensure full compliance with the most recent editions of IAEA's radioactive materials transport regulations.

2 | 2
The quality assurance approach

Within the framework of quality assurance monitoring of transport-related activities, ASN continued its follow-up work on approved packages. Since 1999, every French owner of type B or fissile packages or packages transported by special arrangement has had to update a record sheet for each package concerned, indicating the date of entry into service, modifications undergone, date of last maintenance operation, use to which it has been put, etc.

The collected package record sheets have provided ASN with a clearer picture of the overall French package situation. The 2006 figures show that 16,765 packages were declared, 8,122 of which were used for transport, as opposed to 6,227 in 2005. Packages can be broken down into 85 package models, instead of 89 in 2005. The most common packages are the 48Y cylinders used to transport natural uranium hexafluoride, which account for almost 60% of all French packages (7281 packages, 6037 of which are the property of a single owner, Eurodif Production). In addition, more than 80% of all type B package owners, representing about 4% of all French packages, possess a gammagraph (GAM 80, GAM 120, GAM 400, GMA 2500 and GR 30-50). These devices are intended for the transport of sources in special forms for gamma radiographic non-destructive tests and were the subject of a priority inspection campaign in 2001, which was repeated in 2005 and 2006 to assess change in this area of activity.

In coordination with the DSND, ASN asked the licensees as of 2004 to present an annual summary of the radioactive materials transport activities by the basic nuclear installations. The purpose of this summary is to harmonise the information received by ASN with that from the other nuclear safety authorities. It mainly comprises information concerning transport traffic (internally and on public roads and railways), deviations, events, incidents or accidents and dosimetry records linked to transport activities.

3 INSPECTION AND FIELD SUPERVISION

ASN has implemented inspection provisions involving the Regional Directorates for Industry, Research and the Environment at local level, in similar fashion to the procedures already adopted for basic nuclear installations.

The transport inspector training programmes were repeated in 2006 (about sixty inspectors were trained during 3 sessions). They will be periodically provided to maintain inspector qualification.

From both the regulatory and practical standpoints, it is important to ensure good cohesion with other supervisory authorities responsible, notably, for the inspection of transport vehicles, for labour inspection in the transport sector or for the protection of nuclear materials. This is why ASN has either already signed or will shortly be signing protocols with the Directorate General for the Sea and for Transports (DGMT) and the Directorate General for Civil Aviation (DGAC). The TSN law also reinforced the powers of ASN inspectors, in particular with regard to ascertaining violations and imposing penalties.

In 2006, the radioactive material transport inspection duties, performed by ASN's inspectors, were based around three key topics:
- gamma radiography devices;
- gammadensimeters;
- packages not approved by an Authority.

Checks were therefore carried out in particular on the consignors and carriers. At a more general level, inspections also took place at the manufacturers and on the maintenance sites.

A total of 71 inspections was carried out in 2006 in the field of radioactive material transport.

Transport of gamma radiography devices

In the gamma radiography sector, small companies do not generally have a safety adviser and do not implement quality assurance procedures. Even though the doses received during transport remain very low, radiological protection programmes could often be improved, although in many cases such a programme does not even exist. A reminder of the regulations applicable to the transport of gamma radiography devices was sent out by ASN to the professionals in this sector. A letter was also sent to the main companies which use gamma radiography contractors, reminding them to ensure that their contractors comply with the regulations.

Transport of gammadensimeters

The companies inspected are generally small structures comprising a maximum of about ten people. There is usually no quality assurance programme, nor any radiological protection programme. In only about one third of cases was the conformity of the type A packages demonstrated. Nonetheless, the companies generally have currently valid special source approval certificates. A few companies had no safety adviser. Finally, the marking of certain devices was incomplete. A letter recalling the regulatory requirements will shortly be sent out to all the companies identified as being in possession of or using gammadensimeters.

Non-approved packages

A second inspection campaign on the subject of non-approved packages was carried out in 2006. This mainly concerned type IP-2 packages and type A packages; these inspections confirmed the lax attitude observed in 2005 with regard to demonstrating the conformity of non-approved packages. The inspectors in particular identified the following deviations:
- regulation references are often incomplete or obsolete;
- the allowable contents of the packagings are generally not specified;
- the definition of the packagings (materials, weight, dimension, drawings) is not stringent enough;
- the ability to withstand the routine transport conditions is not proven;
- the penalising nature of the drop tests included in the tests is not proven;
- the radiological protection and containment integrity demonstration is incomplete;
- correct performance of the package between − 40 °C and + 70 °C is not proven;
- the ability of the containment envelope to retain the radioactive contents in the event of an ambient pressure drop to 60 kPa is not proven.

In order to boost the effectiveness of its actions in this field, ASN will soon be sending the licensees a non-approved package conformity guide.

With regard to air transport, surveillance was maintained at Roissy airport in 2006. The inspections were devoted to checking the requirements applicable to companies working in the cargo area. Progress has been achieved by those companies that had previously been inspected, particularly with respect to the radiation protection programmes.

Among the observations or findings formulated further to the inspections, the most frequent concern quality assurance, documentation, the responsibilities of the various parties involved, or compliance with procedures and established practice as indicated in the approval certificates, safety documents or, more generally, regulatory texts.

As regards quality assurance, the observations most frequently encountered concern the following:
- organisation;
- quality plan, procedures, established practice;


ASN inspection at Roissy-Charles-de-Gaulle airport in April 2006

- traceability of checking operations;
- handling of deviations;
- supplier audits.

With regard to the other fields, the observations mainly concern:
- the training programme for all those involved in transport operations;
- the work of the safety adviser, in particular the annual report;
- procedures for declaring events and incidents.

The observations made during the inspections are the subject of follow-up letters published on the www.asn.fr website. ASN asks the licensees to forward the information specified in these follow-up letters, generally within two months. Progress has been observed in the companies already inspected, although certain licensees do need to improve further.

ASN also carried out two inspections on the manufacture of IR 100 packages intended for the transport of fresh or spent fuel, and SORG packages intended for the transport of waste containing organic solvents. ASN aims to intensify package manufacturing inspections.

4 INCIDENTS AND ACCIDENTS

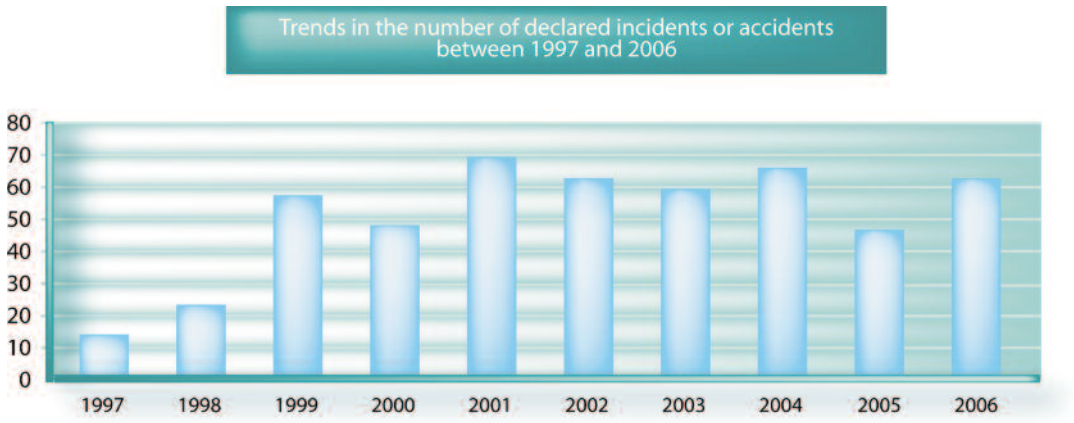
The guide associated with the letter of 24 October 2005, sent out by ASN to all consignors and transporters, redefines the incident and accident declaration criteria initially sent out in the circular of 7 May 1999 (see chapter 4, point 1|2|2). It also reuses the incident report template proposed in the ADR and RID orders.

All transport deviations are thus to be declared to ASN. Apart from this declaration, a detailed incident report must be sent to ASN within two months. Events concerning regulatory nonconformities but which do not impair the safety function are not concerned by this report. In the case of contamination, an analysis report is to be sent to ASN within two months.

The main events that occurred in 2006 are detailed below according to category. These events may be of several types:

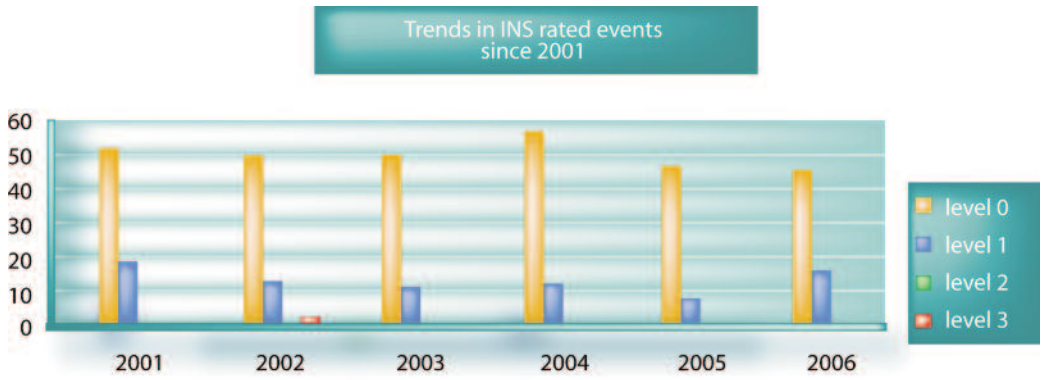
- nonconformity with the requirements of the orders specific to each mode and of the package model approval certificates;
- package handling event;
- incident or accident during actual transport, particularly a stowage fault.

The trend in the number of incidents/accidents reported during the last nine years is illustrated below:



The above graph shows a rise in the number of incidents notified, reflecting the creation of the declaration system, followed by a phase of relative stability. The events notified since 1 October 1999 were rated on the INES scale, which ASN has decided to apply to transport operations. A new version of the INES scale, applicable to transport, has been produced by IAEA and a letter was sent out to all consignors and carriers to ask them to apply it and to inform them that the French translation was available on ASN's website.

In 2006, 46 incidents were rated at level 0, and 16 at level 1. The following graph shows the trends since 2000.



4 | 1

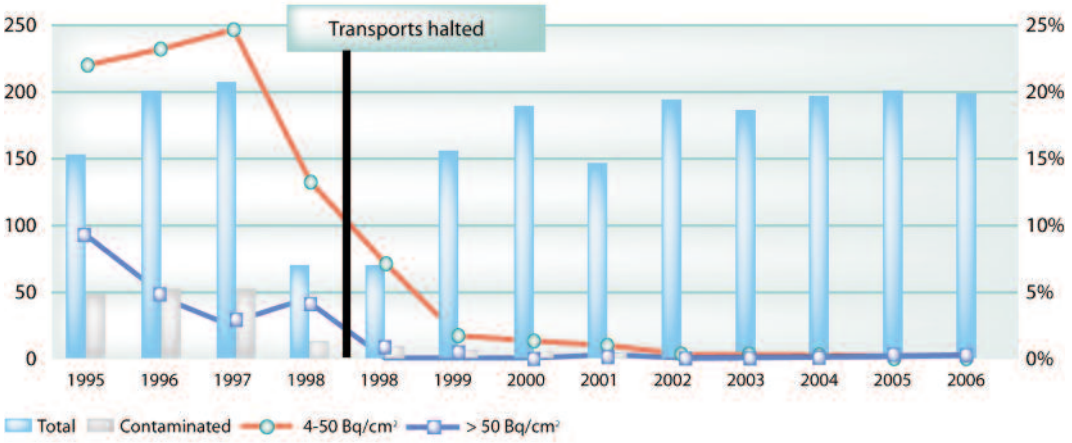
Nonconformity of container or content

Contamination of spent fuel convoys

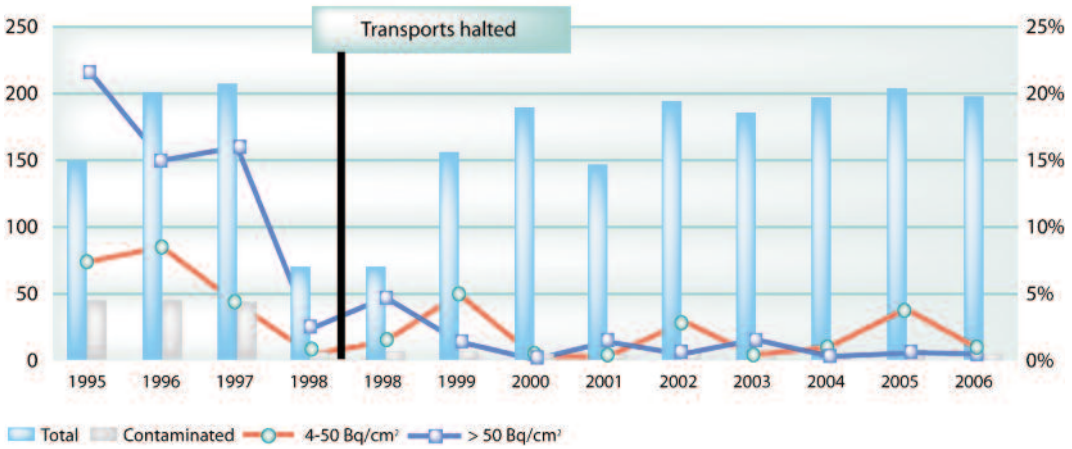
In 2005, the contamination thresholds were found to have been exceeded on several occasions at the Valognes rail terminal or in the EDF plants. In the light of this increase, ASN sent out a letter to EDF management on 25 October 2005, recalling the regulation contamination requirements and asking that corrective measures be taken to prevent such deviations happening again. Immediate corrective measures were thus taken by EDF. Then, in a letter of 3 March 2006, the licensee forwarded the results of its deviations analysis and the additional measures implemented on all the sites.

The proposed corrective action would seem to be effective, given that no contamination incidents were reported in 2006.

Package contamination – results as at 31 December 2006



Wagon and trailer contamination – results as at 31 December 2006



Spent fuel is continuing to be transported normally from foreign countries to La Hague and to Sellafield (Great Britain).

The two graphs show the trend since 1995 in the contamination levels on packages and the means of transport used to carry spent fuel from the EDF plants to the La Hague reprocessing plant.

4 | 2
Package handling events

Airport handling incidents

Handling incidents at airports, involving radioactive material packages, are considered to be transport incidents. Transport in fact comprises all operations and conditions associated with the movement of radioactive materials, especially loading, routing, including interim storage, and unloading.

In 2006, 7 incidents of this type at Roissy-Charles-de-Gaulle airport were identified. These incidents concerned type A packages or excepted type packages, which were damaged to varying extents, although with no breach of the containment.

Four type A or excepted package losses were also declared in 2006. These were packages incorrectly routed from or to the airport. These incidents are rated level 1 on the INES scale.

Two of the packages were not found and contained limited quantities of short half-life radioactive tracers.

Jointly with the DGAC (civil aviation authority) and the air transport police, ASN carried out a number of air cargo inspections. The carriers were reminded of the need to implement a radiation protection programme appropriate to the transport activities, to correctly secure the packages and make the personnel aware of the hazards of ionising radiation.

Photo of a package damaged by a fork-lift truck

4 | 3 Incidents and accidents during actual transport

The following incident is an example of those which occur during actual transport.

In December 2006, a lorry carrying contaminated tools was struck by a car near the town of Mâcon.

The lorry was taking contaminated tools from the AREVA NP site at Chalon-sur-Saône to the EDF power plant at Bugey. These tools were intended for maintenance operations and were packaged in steel crates, secured to a trailer covered with a tarpaulin.

The car driver was injured. The local police and fire brigade set up a safety perimeter of about a hundred metres and asked local residents to stay at home while radiation protection checks were carried out by the fire brigade. No traces of contamination were found. The steel crates were still correctly secured on the lorry and were undamaged. After being checked out, the lorry was able to complete its journey to the plant the next day.

This incident was rated at level 0 on the INES scale.

5 OUTLOOK

Every year in France, large numbers of radioactive material consignments take place. Not only their number, but also the considerable radioactivity involved in some of them, require scrupulous enforcement of the regulations.

In 2006, ASN continued to strengthen the radioactive material transport inspections that it has been carrying out since 1997. It continued the inspections conducted on the radioactive material packaging designers, manufacturers, carriers and consignors; it once again tested its procedures for emergency response to an accident involving the transport of radioactive materials.

The inspections carried out in 2006 show that progress has been made, in particular in drafting the radiation protection programmes that have been mandatory since 2001, but that there is still room for improvement. ASN will be continuing its inspections in 2007.

Furthermore, as a result of the regulation contamination limit overshoots during spent fuel transport operations in 2005, ASN asked EDF to take corrective measures to prevent such deviations occurring again. EDF took immediate steps and initiated an in-depth analysis of the deviations, which could lead to additional measures. The measures taken would seem to have borne fruit in 2006, but ASN will remain attentive to ensuring that there are no further incidents in this area.

Finally, ASN continued the technical background work prior to issue of approval certificates: periodic safety reviews of existing package models and the approval of new models incorporating innovative design features contribute to the overall upgrading of transport safety. This work in particular led to a highly significant drop in the number of special arrangements issued (about fifty in 2000 and about ten in 2005 and 2006).

These actions as a whole have led to an improved and strengthened safety culture among carriers, through assimilation of experience feedback.

ASN also intends to intervene as far upstream as possible in the drafting of IAEA's recommendations. As, by their very nature, the regulations concerning the transport of radioactive materials are the sub-

ject of international exchanges, harmonised interpretation must be a major objective for ASN. The goal is not so much to ensure that the French stance is adopted, as to compare our respective experiences for the benefit of safety. It was in line with this principle that a protocol for mutual recognition of the certificates issued by each authority was signed with the British safety authority in February 2006.

Finally, ASN received an IAEA IRRS mission, with one of its aims being to follow-up the TranSAS appraisal conducted in 2004. IRRS experts observed that ASN had complied well with the recommendations and suggestions made in 2004 and moreover had implemented the good practices identified by TranSAS appraisals carried out in other countries.

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