Transport of radioactive substances

1 Movements and Risks in the Transport Sector
   1.1 The diversity of radioactive substance transport movements
   1.2 Risks associated with the transport of radioactive substances

2 Regulation Duties and Responsibilities in the Transport of Radioactive Substances
   2.1 Regulation of nuclear safety and radiation protection
   2.2 Protection against malicious acts
   2.3 Regulation of the other classes of dangerous goods

3 Development of International and European Regulations on the Transport of Radioactive Substances
   3.1 The different types of package
      3.1.1 Excepted packages
      3.1.2 Non-fissile industrial or type A packages
      3.1.3 Fissile and type B packages
      3.1.4 Type C packages
   3.2 Requirements applicable to each type of package
   3.3 Defining responsibilities in the transport of radioactive substances
   3.4 Monitoring of radiation protection relative to the transport of radioactive substances
   3.5 Regulation of the safety of transport operations within the bounds of nuclear facilities
   3.6 Public information in the transport sector

4 ASN Action in the Transport of Radioactive Substances
   4.1 Delivery of approval certificates and shipment approvals
   4.2 Monitoring all the stages in the life of a package and its shipment conditions
      4.2.1 Package manufacturing inspections
      4.2.2 Maintenance inspections of type B packages
      4.2.3 Inspections of packages not requiring approval
      4.2.4 Inspections of the shipment of packages of radioactive substances
      4.2.5 Management of transport safety
      4.2.6 Analysis of incidents
   4.3 Participation in international relations in the transport sector
      4.3.1 Participation in the work of the IAEA
      4.3.2 Participation in the work of the European Association of Competent Authorities on transport
      4.3.3 Bilateral relations with ASN’s foreign counterparts

5 ASN’s Assessment of the Safety of Transport of Radioactive Substances and Prospects
The transport of radioactive substances is a specific sector of dangerous goods transport characterised by the risks associated with radioactivity.

The scope of regulation of the safety of radioactive substance transport covers various fields of activity in the industrial, medical and research sectors. It is based on stringent and restrictive international regulations.

1 MOVEMENTS AND RISKS IN THE TRANSPORT SECTOR

1.1 The diversity of radioactive substance transport movements

Fifteen million dangerous goods packages are transported each year in France. The regulations place these packages in different risk classes. Class 1, for example, corresponds to explosive materials and objects, class 3 to flammable liquids, and class 6 to toxic and infectious materials. Class 7 corresponds to hazardous radioactive material.

About 600,000 shipments of radioactive substances are transported each year in France. That corresponds to about 900,000 packages of radioactive substances, which represent just a few per cent of the total number of dangerous goods packages transported each year in France.

The nuclear industry only represents about 15% of the annual transport movements of radioactive substances: 85% of the transported packages are intended for the medical, 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 shipments involving 141,000 packages. These include approximately:

– 1,000 shipments from or to foreign countries or transiting via France, representing about 50,000 packages;
– 300 shipments of new uranium-based fuel and some 30 shipments of new uranium and plutonium-based “MOX” fuel;
– 200 shipments transporting spent fuel from the nuclear power plants operated by EDF to the La Hague reprocessing plant operated by AREVA;
– about 60 shipments of plutonium in oxide form transported from the La Hague reprocessing plant to the MELOX fuel production plant in the Gard département;
– 250 shipments of uranium (UF₆) hexafluoride necessary for the fuel manufacturing cycle.

The field of nuclear industry research, which essentially concerns the CEA (Alternative Energies and Atomic Energy Commission), accounts for a little less than 3,000 shipments per year transporting about 8,000 packages.

1.2 Risks associated with the transport of radioactive substances

The content of the packages is highly diverse: their radioactivity can vary over more than twelve orders of magnitude, that is to say from a few thousand becquerels for low-activity pharmaceutical packages, to quadrillions (millions of billions) of becquerels for irradiated fuel. Their weight also varies from a few kilogrammes to about a hundred tonnes.

The major risks involved in the transport of radioactive substances are:

– the risk of external irradiation of persons in the event of damage to the “biological protection” of the packages, a technical material that reduces the radiation received through contact with the package;
– the risk of inhalation or ingestion of radioactive particles in the event of release of radioactive substances;
– contamination of the environment in the event of release of radioactive substances;
– the starting of an uncontrolled nuclear chain reaction (“criticality safety” risk) that can cause serious irradiation of persons if water is present and the safety of fissile radioactive substances is not controlled.

Moreover, the radioactive substances can also be toxic and corrosive. This, for example, is the case with shipments of natural uranium with low radioactivity, for which the major risk for man is the chemical risk if it is ingested. Similarly, uranium hexafluoride (UF₆), used in the manufacture of fuels for nuclear power plants can, in the case of release and contact with water, form hydrofluoric acid, a powerful corrosive and decalcifying agent.

Catering for these risks implies having full control over the behaviour of the packages to avoid any release of material and deterioration in the package protection in the event of:

– fire;
– physical impact further to a transport accident;
– ingress of water into the packaging, as water facilitates chain nuclear reactions in the presence of fissile substances;
– chemical interaction between the various constituents of the package;
– substantial release of heat from the transported substances, to avoid possible heat damage to the package constituent materials.

1. The statistical data provided in this chapter are taken from data collected in 2002. A new study scheduled in 2012 should enable these data to be updated in 2013.
This approach means that safety principles must be defined for the transport of radioactive substances:

- safety is based first and foremost on the robustness of the package: regulatory tests and safety demonstrations are required by the regulations to prove that the packages can withstand reference accidents;
- the required level, particularly with regard to the reference accidents that the package must withstand, depends on the level of risk presented by the package.

### Table 1: Breakdown of shipments by mode of transport

<table>
<thead>
<tr>
<th>Approximate number of packages and shipments</th>
<th>Rail</th>
<th>Sea</th>
<th>Sea and rail</th>
<th>Road</th>
<th>Road and air</th>
<th>Road and rail</th>
<th>Road and sea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packages approved by ASN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of packages</td>
<td>20</td>
<td>50</td>
<td>90,000</td>
<td>150</td>
<td>130</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>Number of shipments</td>
<td>20</td>
<td>415</td>
<td>58,000</td>
<td>70</td>
<td>110</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Packages not requiring approved by ASN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of packages</td>
<td>3,900</td>
<td>20</td>
<td>21,300</td>
<td>760,000</td>
<td>45,000</td>
<td>1,400</td>
<td>14,200</td>
</tr>
<tr>
<td>Number of shipments</td>
<td>30</td>
<td>20</td>
<td>100</td>
<td>542,000</td>
<td>14,000</td>
<td>460</td>
<td>280</td>
</tr>
</tbody>
</table>
2 REGULATION DUTIES AND RESPONSIBILITIES IN THE TRANSPORT OF RADIOACTIVE SUBSTANCES

2.1 Regulation of nuclear safety and radiation protection

The objective of ensuring the safety of shipments of radioactive substances is to prevent nuclear accidents and their radiological consequences for people, by implementing organisational and technical measures.

In France, ASN has been responsible since 1997 for regulating the safety of transport of shipments for civil uses, while ASND (the defence nuclear safety authority) fulfills this role for the shipments relating to national defence. ASN’s action in the field of transport comprises:

– 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 the shipment and transportation of the packages.

Section 4 of this chapter gives more details on these inspections.

2.2 Protection against malicious acts

The prevention of malicious acts consists in preventing sabotage, losses, disappearances, theft and misappropriation of nuclear materials that could be used to manufacture weapons. In the regulatory framework, the Defence and Security High Official (HFDS), under the Ministers responsible of Energy and Defence, represent the Authority responsible for preventing malicious acts targeting nuclear materials. In practice, it is the HFDS of the Ministry in charge of Ecology who is delegated this role by the two abovementioned HFDS’s.

2.3 Regulation of the other classes of dangerous goods

Regulation of the transport of dangerous goods is monitored by the MTMD (Hazardous Materials Transport Mission) of the Ministry in charge of Ecology. This entity is tasked with ensuring the measures relative to the security of transport of dangerous goods other than class 7 (radioactive) by road, rail and inland waterways. It has a consultative body (CITMD – Interministerial Hazardous Materials Transport Committee) that is consulted for its opinion on any draft regulations relative to the transport of dangerous goods by rail, road or inland waterway.

Inspections on the ground are ensured by land transport inspectors attached to the DREALs (Regional Directorates for the Environment, Planning and Housing).

For the regulation action to be as consistent as possible, ASN collaborates regularly with the administrations responsible for applying the regulations in their particular sector of activity. For example, in 2012 ASN took part in the training of the DGAC (Civil Aviation General Directorate) inspectors responsible for monitoring the air transport of hazardous goods to present the specificities of class 7 and the experience feedback of ASN’s inspections on these subjects.

The breakdown of ASN’s various missions is summarized in the table below.

<table>
<thead>
<tr>
<th>Mode of transport</th>
<th>Regulation of mode of transport</th>
<th>Package regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road, rail, inland waterways</td>
<td>General Directorate for Energy and Climate (DGEC) of the Ministry of Ecology, Sustainable Development and Energy.</td>
<td>The General Directorate for Risk Prevention (DGPR) is responsible for regulating packages of dangerous goods in general and in close coordination with ASN for radioactive substances.</td>
</tr>
<tr>
<td>Air</td>
<td>The General Directorate for Civil Aviation (DGAC) of the Ministry of Ecology, Sustainable Development and Housing (MEDDE).</td>
<td>The DGAC is competent to regulate packages of dangerous goods in general and in close coordination with ASN for packages of radioactive substances.</td>
</tr>
</tbody>
</table>
The international nature of radioactive substance transport has given rise to regulations, drafted under the supervision of IAEA (International Atomic Energy Agency), that ensure a high level of safety.

3.1 The different types of package
The degree of safety of the packages of radioactive substances is adapted to the potential danger of the material transported. There are five broad types of packages: excepted packages, industrial packages, type A packages, type B packages and type C packages. These package types are determined according to the characteristics of the transported material, such as the total radiological activity, the specific activity - which corresponds to the level of concentration of the material, its physical-chemical form or the possible presence of fissile radioactive substances that could cause a nuclear chain reaction.

3.1.1 Excepted packages
Excepted packages are used to transport very small quantities of radioactive substances, such as very low activity radiopharmaceuticals. These packages are not subject to any qualification tests. They must nevertheless comply with a number of general specifications, notably with regard to radiation protection, to guarantee that the radiation around the excepted packages remains very low.

3.1.2 Non-fissile industrial or type A packages
Industrial packages are used to transport material with low-level activity. Uranium-containing materials extracted from foreign uranium mines are, for example, transported in France in industrial drums with a capacity of 200 litres loaded into 20-foot containers or conventional rail wagons.

Type A packages can, for example, be used to transport radioisotopes for medical purposes commonly used in nuclear medicine departments, such as technetium generators.

3.1.3 Fissile and type B packages
Type B packages allow the transport of large quantities of some of the most radioactive substances such as spent fuels, vitrified high-activity long-lived nuclear waste and fresh fuels. Given the level of risk associated with these packages, they are subject to an approval delivered by ASN based on the examination of a safety file. Approximately 60,000 type B packages are transported each year in France, essentially for the nuclear industry and for industrial technical controls, including industrial radiology.

Type A packages and industrial packages containing fissile radioactive substances are also subject to ASN approval.

3.1.4 Type C packages
Type C packages are designed for transporting highly radioactive substances by air. In France there is no approval for type C packages for civil uses.

3.2 Requirements applicable to each type of package
The regulations define safety requirements for each type of package, including tests to assess their robustness.

The regulations thus require that type A packages that contain no fissile materials (such as enriched uranium), be designed to withstand incidents that can occur during handling or storage operations. They must therefore be subjected to the following tests:

- exposure to a severe storm (rainfall reaching 5 cm/hour for at least 1 hour);
- drop test onto an unyielding surface from a height varying according to the mass of the package (maximum 1.20 m);
- compression equivalent to 5 times the weight of the package;
- penetration by dropping a standard bar onto the package from a height of 1 m.

Additional tests are required if the content of the package is in liquid or gaseous form.

Type A packages are not subject to ASN approval: the package design and performance of the tests are the responsibility of the manufacturer. These packages and their safety demonstration files are inspected by the ASN inspectors.

Type B packages, which are used to transport the most dangerous materials, must be designed such that safety is guaranteed, including in the event of transport accident. These accidents are represented by the following tests:

- three consecutive tests:
  - a 9 m drop test onto an unyielding surface;
  - a 1 m drop onto a spike;
  - encircling fire of at least 800°C for 30 minutes;
- immersion in 15 m deep water for 8 h (200 m water depth for spent fuel).

These tests, which are comparable with automotive industry “crash tests”, have been recommended by the International Atomic Energy Agency (IAEA). They have been designed, firstly to cover 95% of the most severe accidents, and secondly with the aim of being readily reproducible from one country to another. These tests are thus recognized and applied very widely by the IAEA member countries. Their performance is obligatory within the European Union.
3.3 Defining responsibilities in the transport of radioactive substances

The main participants in transport arrangements are the consignor and the carrier.

The consignor is responsible for package safety and accepts its responsibility by way of the dispatch note accompanying the package remitted to the carrier. The carrier is responsible for carriage of the shipment to its destination. 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 substance shipment to be carried out in satisfactory conditions of safety, a stringent chain of responsibility has to be set up. So, for major transport operations:

- the corresponding packaging must be designed and sized in accordance with conditions of use and the current regulations. The designer must have lodged an ASN-approval application and obtained it;
- the manufacturer must produce packaging in accordance with the description given in the approval;
- the consignor must check that the material is authorised for transport and only use approved, correctly maintained packagings that are suitable for the goods in question, and comply with requirements concerning the mode of transport and the shipment restrictions. The consignor must more particularly carry out the inspections of leak-tightness, dose rate, temperature, contamination, and mark and label the packages. It must also provide the carrier with all the required documents and information;
- the actual transport is organised by the carriage commission agent. The carriage commission agent is responsible for obtaining all the necessary authorisations on behalf of the consignor, and for sending the various notices. He also selects the means of transport, the carrier and the itinerary, in compliance with the regulatory requirements;
- the carrier, usually a specialised company with the necessary authorisations, appropriate vehicles and duly trained drivers, must verify the completeness and availability of the information provided by the consignor, and the good overall condition and correct labelling of the vehicles and packages. It must also verify that the materials to be transported are authorised for transport;
- the consignee is under the obligation not to postpone, without vital reason, acceptance of the goods and to verify, after unloading, that the requirements of the corresponding ADR have been satisfied;
- finally, the container owner must set up a maintenance system in conformity with that described in the safety documents and the authorisation certificate.

The transport of some radioactive substances (including packages containing fissile material) is subject to prior notification to ASN and the Ministry of the Interior by the consignor. The notification indicates the materials transported, the packages used, the transport conditions and the contact details of the persons involved. 1277 notifications were addressed to ASN in 2012.

3.4 Monitoring of radiation protection relative to the transport of radioactive substances

The radiation protection of workers and the public around shipments of radioactive substances must be a constant concern.

The general regulations relative to radiation protection provided for by the Public Health Code and by the Labour Code also apply to the transport of radioactive substances as a nuclear activity in its own right: the public and non-specialised workers must not be exposed to a dose exceeding 1 milliSievert (mSv) per year. However, this limit is not intended to be an authorisation to expose the public to up to 1 mSv: the regulations provide that any exposure, even low, must be both justified and optimised. These principles, applicable to any nuclear activity, apply particularly to the transport of radioactive substances.

Radiation protection forms the subject of specific requirements in the regulations applicable to the transport of radioactive substances. Thus, for transport by road, the regulations stipulate that the radiation at the surface of the package must not exceed 2 mSv/h (this limit can be increased to 10 mSv/h in the case of exclusive use, where actions near the package are limited). The radiation on the outer surface of the vehicle must not exceed 2 mSv/h, and must be less than 0.1 mSv/h at a distance of 2 metres from the vehicle.

Assuming that a transport vehicle reaches the limit of 0.1 mSv/h at 2 metres, a person would have to spend 10 hours without interruption at a distance of 2 metres from the vehicle for the radiation dose received to reach the annual public exposure limit.

2 ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road, concluded in Geneva on 30th September 1957, including the amendments in force on 1st January 2011.
These limits are supplemented by requirements relative to the organisation of radiation protection within companies. The transport stakeholders must establish a radiological protection programme that integrates the measures taken to optimise human exposure. It may be necessary to implement dosimetric monitoring of the exposed person. Training is also a key factor in the radiological protection programmes.

This training is also required by the regulations. All the stakeholders in the transport chain must thus be trained and made aware of the nature of the risks associated with radiation so that they can protect themselves and others against them.

3.5 Regulation of the safety of transport operations within the bounds of nuclear facilities

Dangerous goods transport operations can take place on the private roads of nuclear sites, in what are referred to as “on-site transport operations”. Such operations are not subject to the regulations governing the transport of dangerous goods, which only apply on public highways.

On-site radioactive substance transport operations are currently governed on nuclear sites by “internal transport rules” specific to each site.

The “BNI” order published on 7th February 2012 (see chapter 3) requiring the integration of on-site transport operations in the baseline safety standard of basic nuclear installations, will come into force on 1st July 2013. The on-site transport of dangerous goods presents the same risks and inconveniences as the transport of dangerous goods on the public highway. The safety of transport must be overseen with the same rigour as for any other risk or inconvenience present within the bounds of the BNI.

ASN met representatives of the AREVA La Hague and Tricastin sites and the CEA Cadarache site several times in 2012 in anticipation of entry into effect of the order and to assist them in their steps to comply with these new regulations. These three sites have started to integrate on-site transport of radioactive substances in the safety baseline standard of their nuclear facilities. This approach is to be extended to the transport of hazardous goods in other classes carried out on the other AREVA and CEA sites.

Furthermore, certain on-site radioactive substance transport operations carried out on BNI 116 at AREVA’s La Hague site shall be jointly reviewed by the Advisory Committees of experts for “Transport” and “Plants” at the end of 2013.

3.6 Public information in the transport sector

Order 2012-6 of 5th January 2012 extends the public information obligations to persons responsible for nuclear activities. It is Article L. 125-10 of the Environment Code that sets the threshold beyond which the person responsible for transport must communicate the information requested by a citizen, by reclassification of the provisions of decree 2011-1844 of 9th December 2011. The thresholds are defined as being those “above which, in application of the international conventions and regulations governing the transport of dangerous goods, of the Code of Transport and of the texts taken for their application, the transport of radioactive substances is subject to the delivery – by ASN or by a foreign Authority competent in the field of radioactive substance transport – of an approval of the transport package design or a shipment approval, including under special arrangement”. Any citizen can therefore now ask the persons in charge of transport for information on the risks presented by the transport operations referred to in the decree.

A person to whom a nuclear licensee or transport supervisor has refused to communicate information, can refer the matter to the CADA (Administrative Documents Access Commission), instituted by Article 20 of the Act of 1978, for its opinion. The matter must be referred to the CADA prior to any legal action. Disputes relative to communication refusals can then be brought before the administrative jurisdictions, even if they are between two private individuals.
运送放射性物质

4.1 送达审批证书及装运

为了验证类型B的包裹和包含易裂变物质的包裹符合所有监管要求，ASN会要求IRSN（辐射防护与核安全研究所）评估包材安全证明文件。ASN会在技术审查基础上做出审批决定，可能还要求在下一轮审批日期前将更多信息添加到安全文件中。

在某些情况下，IRSN的评估会由运输放射性物质专家委员会（GPT）的会议补充。专家委员会的意见总在www.asn.fr上发布。

例如，GPT在2011年两次会议中审查了CEA开发的DE 25新包材概念。

这些审批证书通常颁发期限为几年。目前，大约每年100份审批申请由制造商提交给ASN。审批证书说明了包材制造、操作和维护条件。

审批证书一般独立于装运操作颁发，从技术上讲，一般不需要事先通知ASN，但也可能涉及安全检查（由国防和安全高官在生态、可持续发展和能源部控制下的物理保护）。

当运输要求未被完全满足时，装运可以以特殊安排形式批准。申请需证明至少存在等价的运输条件来补偿未完全满足某些“标准”要求。

对于在国外颁发的证书，国际法规允许其认可（验证）。验证可以通过在原始证书上加注或由负责国颁发单独的审批来表示。

4.2 ASN行动在运送放射性物质

图1：按类型划分的审批数量

图2：按内容划分的审批数量

### 图1：按类型划分的审批数量

<table>
<thead>
<tr>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### 图2：按内容划分的审批数量

<table>
<thead>
<tr>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
ASN delivered 50 approval certificates in 2012, for which the breakdown by type is shown in graph 1.

The breakdown and nature of the transport operations concerned by these certificates in 2012 are shown in graph 2.

Finally, in May 2009, ASN published an applicant’s guide for approval of shipments and package designs or radioactive substances for civil purposes transported on the public highway. The guide presents ASN’s recommendations to the applicants, to facilitate reviewing of the package approval applications and of the shipment approvals for the transport of radioactive substances. It also specifies how the safety cases are to be transmitted to ASN and to IRSN, their structure, the contents of the draft approval certificate, the operating experience feedback from previous reviews and the requirements to be met if a package design or material is modified. This guide was translated into English in 2010, for distribution to some of the European Union competent authorities for transport issues. This guide was updated in 2012. All the stakeholders (ASN, IRSN, applicants and foreign nuclear authorities) responded to this consultation and helped produce this draft guide. This new version takes up points of doctrine that were previously disseminated as circular letters, in order to improve the clarity and group 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 (values applicable for securing 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 inside the cavity of a package during the regulatory drop test from a height of 9 m, etc.). This appendix is intended to be added to each time the guide is revised, which ASN would now like to be done annually.

4.2 Monitoring all the stages in the life of a package and its shipment conditions

ASN performs inspections at all stages in the life of a package, from manufacture and maintenance through to package preparation, carriage and reception. In 2012, ASN carried out some one hundred inspections in radioactive substance transport (all sectors considered).

4.2.1 Package manufacturing inspections

The manufacture of transport packaging is subject to the regulations for the transport of radioactive substances. In accordance with the regulatory requirements, each manufacturer of an approved package design must be able to provide ASN with all the elements for ensuring the conformity of packaging manufacture with the package design specifications approved by ASN. These specifications are defined in the safety file specific to each packaging, which represents the demonstration of safety for the package design. The safety file sets the objectives in terms of packaging design. It contains all the elements relative firstly to the requirements concerning the packaging and its content, and secondly to the tests that can be required to demonstrate the safety of the package design.

The role of ASN is to check that the manufacturing specifications and the inspection procedures match up to the design requirements defined in the safety file.

The quality assurance system is applied and conformity with the safety file specifications is ensured in all the operations from procurement through to final inspection.

In 2012 ASN inspected the manufacture of 30B cylinders used to transport uranium hexafluoride, and the manufacture of elastomer seals used for spent fuel packages.

The follow-up letters to these inspections are available on www.asn.fr.

During these inspections, ASN checks the quality assurance system implemented for the production of a package from the design data, and the traceability of in-process inspections and any deviations.

It also visits the manufacturing shops to check the package component storage conditions and the conformity of the various manufacturing operations (welding, assembly, etc.).

When subcontractors are used, ASN checks the monitoring of manufacturing by the manufacturer in charge and intervenes directly on the manufacturing sites, which are sometimes located
in foreign countries. Thus, for the inspection of the manufacture of the 30B cylinders, ASN inspected a production factory in China in June 2012.

In parallel with these package manufacturing inspections, ASN inspects the manufacture of the specimens used for the regulatory drop tests and fire tests. The objectives are the same as for the series production model, because the specimens must be representative and comply with the minimum requirements indicated in the mock-up manufacturing file, which will determine the minimum characteristics of the actual packaging to be manufactured.

In 2012 ASN reinspected the manufacture of the DN30 specimen overpack for transporting the 30B cylinders filled with UF₆. The reason for this was that a new test campaign was carried out in 2012 with new specimens whose design had changed.

4.2.2 Maintenance inspections of type B packages

The consigner or user of a package filled with radioactive substances must be ready to prove to ASN that this package is periodically inspected and, if necessary, repaired and maintained in good condition such that it continues to satisfy all the relevant requirements and specifications of its safety file and approval certificate, even after repeated use. For type B packages, the ASN inspections concern the following maintenance activities, for example:

- the periodic inspections of the components of the containment envelope (screws, bolts, welds, seals, etc.)

Enriched uranium in the form of UF₆ produced from natural or reprocessed uranium is transported in 30B cylinders enclosed in an ASN-approved overpack (UX30, COG-OP-30B, MST30, MST 30R, etc.). The overpack approval certificates authorise the use of 30B cylinders complying with standard ISO 7195: 2005 “Packaging of uranium hexafluoride (UF₆) for transport” or standard ANSI N14.1 “Uranium hexafluoride - Packaging for transport”.

On 20th and 21st June, two inspectors in the nuclear safety of radioactive substance transport went to Nantong (China) to inspect CIMC ENRJC, a Chinese factory that manufactures 30B cylinders for transporting UF₆. They watched various manufacturing operations: welding, pressure test, measurement of cylinder capacity, and leak test.

They focused on the obligations of TN International, the entity responsible for the manufacture of the packages, and more particularly:

- the quality assurance programme put in place;
- the relations between the different entities involved (EDF, TN International, Columbiana Hi Tech (CHT), and China International Marine Containers (CIMC));
- the conformity of the manufacturing operations and compliance with standards ISO 7195 and ANSI N14.1;
- personnel training.
– the periodic inspections of the securing and handling components;
– the frequency of replacement of the package components which must take account of any reduction in performance due to wear, corrosion, aging, etc.

In 2012, ASN carried out six targeted inspections on the maintenance of packages in the nuclear power industry cycle.

4.2.3 Inspections of packages not requiring approval

For the packages that do not require ASN approval (see chapter 3), the consigner must be able, at the request of ASN, to provide the documents proving that the package design complies with the applicable requirements. More specifically, for each package, a certificate delivered by the manufacturer attesting full compliance with the design specifications must be held at the disposal of ASN.

The various inspections carried out in 2012 reveal an improvement in the documents presented to ASN and the first steps to integrate the recommendations ASN gives in its guide for packages which are not subject to approval.

In 2012, ASN worked on the updating of this guide which is available at www.asn.fr. It proposes a structure and minimum content for the safety files demonstrating that packages which are not subject to approval do comply with all the applicable requirements, along with the minimum content of a declaration or certificate of conformity of a package design with the regulations.

Nevertheless, ASN still finds that some of the entities concerned (designer, manufacturer, distributor, owner, consigner, companies performing the regulatory drop tests, package maintenance, etc.) display shortcomings in the demonstration of package conformity with the regulations. The areas for improvement concern the following points in particular:
– the description of the authorised contents per type of package;
– demonstration that there has been no loss or dispersion of the radioactive content under normal transport conditions;
– compliance with the regulatory radiation protection requirements;
– the representativeness of the tests performed.

4.2.4 Inspections of the shipment of packages of radioactive substances

ASN devotes more than half of its transport inspections to the checking of shipments and carriers, at both regional and national level.

During these inspections, the checks concern all the regulatory requirements incumbent upon each stakeholder in the transport process, grouped around two themes: the organisation of the company and the procedures or measures implemented to verify conformity of the transport process with the regulations.

Among the observations or findings formulated further to the inspections, the most frequent are about quality assurance, documentation, or compliance with procedures and established practices as indicated in the approval certificates, safety files or, more generally, regulatory texts.

ASN’s inspections reveal deficiencies in the knowledge of the regulations and responsibilities on the part of the transport stakeholders in small-scale nuclear activities.

Knowledge of the regulations applicable to the transport of radioactive substances seems to be substandard in the medical sector in particular, where the measures taken by some hospitals or nuclear medicine units when returning radionuclide packages after use and shipping sources for maintenance need to be tightened.

ASN has moreover observed that an increasing number of BNIs are using outside contractors to prepare and ship packages of radioactive substances ASN will be particularly attentive to the monitoring of these service providers.

4.2.5 Management of transport safety

At the end of 2012, ASN conducted three technical visits to the major players in radioactive substance transport for the fuel cycle, namely AREVA, EDF and the CEA, in order to assess the management of safety in this area. The findings of these visits are currently being analysed and will lead to an action plan in 2013.
Analysis of incidents

By listing and analysing the various transport incidents, ASN can identify the problems faced by the transport operators and the possible safety risks, in order to improve current practices and identify any needs for changes in the regulations.

Any deviation from the regulations or the safety files relative to the transport of radioactive substances must be notified to ASN in accordance with the events notification guide, as required by Article 7 of the TMD order. This events notification guide was communicated by letter to the various stakeholders in the transport of radioactive substances on 24th October 2005 and can be consulted on www.asn.fr. It defines the various conditions of notification and classification of transport events on the INES scale. Apart from the notification, a detailed incident report must be sent to ASN within two months.

Events declared in 2012

52 events rated level 0, six events rated level 1, and one event rated level 2 on the INES scale were notified to ASN in 2012. Graph 3 shows the trend for the number of events notified since 2001.

One level-2 event nevertheless occurred in 2012, involving the loss of a package containing radioactive fluorine for medical purposes (see box).

The drop in the number of events observed in 2011 and 2012 can essentially be explained by a change in the recording of events concerning impacts on radiopharmaceutical packages in airports. To facilitate incident analysis, the corresponding notification criterion was adjusted so that only significant impacts that could affect the safety of the package are taken into account. Minor impacts having no consequences must now simply be traced, and no longer notified to ASN.

Areas of activity concerned by these events

More than half of the events are notified by the industrial stakeholders in the nuclear cycle (EDF and AREVA in particular). About 17% of the events concern the radioactive pharmaceutical products shipped by CIS Bio International.

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 packaging, etc. Graph 4 shows the breakdown of notified transport events by content and mode of transport. It can be seen that few events concern the transport of nuclear fuel or waste.

Road transport accounts for the majority of the notified events. The proportion of events concerning air transport, about 16% in 2012, reflects greater awareness of the airport companies that detect deviations and are more familiar with the notification process. These events essentially involve package impacts or falls during handling, or temporary or definitive losses in transit. Few events involve rail or maritime transport. These figures are in agreement with transport movements in France.

**Causes of events**

The events notified in 2012 chiefly concern:
- several package classification errors (for example, shipment in an industrial package instead of a type-A package);
- losses of medical packages during transits in airports (temporary or definitive loss);
- insufficient or deficient securing of packages of material transported for EDF;
- falls or impacts during the handling of medical packages in airports;
- exceeding the contamination and radiation intensity limits (without involving exposure or contamination of individuals);
- noncompliance with the regulatory requirements of the applicable orders (e.g. the TMD order for land transport);
- loose attaching screws on spent fuel package covers.

The breakdown of notified transport events according package to content and mode of transport is illustrated in graph 4.

2012 saw an increase in events related to incorrect classification of the transported contents leading to the use of an inappropriate package.

### Participation in international relations in the transport sector

The international regulations were drafted and are implemented as a result of fruitful exchanges between countries. ASN places these exchanges in a process of continuous progress in the level of safety of radioactive substance shipments, and encourages exchanges with its counterparts in other countries.

#### Participation in the work of the IAEA

ASN represents France on the Transport Safety Standards Committee (TRANSSC) which, under the supervision of IAEA, comprises experts from all countries and drafted the document (TS-R-1) which underpins the regulations applicable to the transport of radioactive substances. 2011 saw the conclusion of the revising of regulation TS-R-1, which began in 2008. The new 212 edition integrates modifications in the objective of harmonising practices with the UN recommendations for the transport of dangerous goods.

The most important changes concern criticality safety, with the modification of the configurations of substances classified as excepted fissile substances, materials for which no demonstration of criticality safety is required at present, subject to compliance with the weight limits per package and per consignment. These modifications could more particularly have an impact on the transport of waste containing fissile radionuclides, which will become subject to safety demonstration requirements.

#### Participation in the work of the European Association of Competent Authorities on transport

The European Association of Competent Authorities in the transport of radioactive materials (EACA) was created in December 2008. Its purpose is to promote the harmonisation of practices in the regulation of the safety of transport of radioactive substances, and to encourage exchanges and experience feedback between the various Authorities. The
plenary meeting of June 2012, for example, provided the opportunity to work on the finalising of the content of a European inspection guide, which can be used by the inspectors of all the European Authorities. It also provided the opportunity to finalise the European guide relative to the safety files for package designs intended for transporting radioactive substances, called the PDSR (Package Design Safety Reports) Guide, applied by all the European competent authorities.

4.3.3 Bilateral relations with ASN’s foreign counterparts
ASN devotes considerable effort to maintaining close ties with the competent authorities of the countries concerned by the numerous shipments to and from France. Prominent among these are Belgium, the United Kingdom, Germany, the United States of America and Switzerland.

Belgium
For its production of electricity from nuclear power, Belgium uses French designed containers for fuel cycle shipment. In order to harmonise practices and achieve progress in the safety of these shipments, ASN and the competent Belgium authority (Belgian Federal Nuclear Regulating Agency - AFCN) regularly exchange know-how and experiences.

Since 2005, an annual exchange meeting is held by ASN and AFCN in order to take a closer look at the safety analysis reports for the French package designs validated in Belgium. These exchanges were supplemented in 2012 by an AFCN presentation to ASN inspectors of its policy with regard to disciplinary measures in nuclear transport.

ASN also took part in a cross-inspection campaign with the AFCN inspectors. This inspection campaign focused on the transport and shipping of radiopharmaceutical products, the transport of UF₆ and the shipping of UF₆ cylinders by boat. This provided the opportunity to discuss practices with regard to inspection and the monitoring of carriers and movements of goods in the two countries.

The United Kingdom
Over the last few years ASN and the United Kingdom’s Office for Nuclear Regulation (ONR) have developed a close collaboration. Both countries underwent a review coordinated by the IAEA, demonstrating the high level of competence of the two authorities with regard to radioactive substance transport, thus enhancing their mutual trust and confidence.

Against this backdrop, ASN and the ONR signed a memorandum of understanding on 24th February 2006, for the mutual recognition of the approval certificates confirming the safety of radioactive substance transport.

Having successfully cooperated on the Memorandum of Understanding signed in February 2006, ASN and the ONR extended their cooperation on the following subjects, through an agreement concluded on 27th February 2008:
– licensing procedures;
– inspections;
– emergency procedures;
– guides for domestic and international transport of radioactive substances;
– radioactive substance transport standards;
– quality assurance systems.

Since 2006, two discussion meetings are organised annually between ASN and the ONR, to enable them to work more closely together, in particular on reviewing the safety files relative
to the package designs used in the United Kingdom and France. One joint review of this type was conducted in 2012 to evaluate the safety of a British package design intended for the transportation of plutonium powder between France and the United Kingdom.

**Germany**

The French and German nuclear authorities have decided to regularly meet to discuss certain technical files. Large quantities of shipments cross the Franco-German border. Thought is being given to implementing a Memorandum of Understanding for approval recognition, along the lines of that concluded by ASN with the British regulator. ASN participates in the Franco-German technical committees concerning the schedule for returning the waste resulting from the reprocessing of German spent nuclear fuel. A new package is currently being designed in Germany for the transport of compacted waste. In this context, ASN attended a technical meeting on the package specifications, equivalent to the safety option file in France, and it will participate in the technical meetings concerning the drop tests when the time comes.

**The United States**

The United States authorities (Nuclear Regulatory Commission - NRC and Department of Transportation - DOT) contacted ASN with a view to setting up collaborations on subjects of joint interest. Without waiting for this approach to be formalised, close collaboration between the French and American Authorities was initiated in 2011 to draw the lessons from the transport events observed on a package of American design intended for the transportation of UF₆.

**Switzerland**

ASN began bilateral exchanges with the Swiss Federal Inspectorate for Nuclear Safety (IFSN) in 2012. On 4th June 2012, the IFSN conducted an inspection of the shipment of a TN 9/4 package loaded with spent fuel in the Mühleberg nuclear power plant in Switzerland. The IFSN inspectors were assisted by an ASN inspector and an expert from IRSN. In 2011, the TN 9/4 package received an approval certificate delivered by the ASN and validated by the IFSN. As is the case with other packages validated in Switzerland, the French approval certificate contains new instructions for use. Double-checks are now required during pre-transport preparation for the drying operations, leak-tightness inspections and tightening of the cover and orifice closing mechanisms. The IFSN asked ASN for its assistance in verifying that these new requirements were indeed applied. An additional aim of this inspection was to discuss the reasons for introducing these new instructions and the dosimetric impact of the new checks.

ASN and the IFSN have decided to meet regularly to discuss the package design safety files and the checks on the instructions associated with the correct utilisation of these transport packages.

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**5 ASN’S ASSESSMENT OF THE SAFETY OF TRANSPORT OF RADIOACTIVE SUBSTANCES AND PROSPECTS**

ASN presented an assessment of the safety of transport of radioactive substances in France based on event notifications communicated to ASN and on the inspections covering the period from 2007 to 2011, to the members of the Advisory Committee of transport experts and the members of the Transport Safety Commission (Advisory Committee of transport experts called upon by the ASND, the authority responsible for nuclear transport associated with national defence) at the end of 2012. It gave rise to a report that will be available on www.asn.fr in 2013.

Lines of improvement concerning the preparation, organisation and shipping of packages to BNIs have been identified, as is the case for the carriage of packages, the manufacture and maintenance of packagings, the reviewing of approval applications and the management of emergency situations.

Production of the report is also based on comparisons with the foreign nuclear regulators’ inspection practices and some general observations raised when reviewing the approval applications. An action plan for the transport field will be developed on the basis of this report.

**Increase in safety requirements relating to on-site transport operations performed within the bounds of the BNIs**

As part of the revision of the technical regulations for BNIs, ASN has planned to tighten the regulatory framework and the requirements concerning on-site transport operations performed within the bounds of the BNIs. The nuclear sites concerned must take prompt action to plan the necessary modifications to the existing baseline safety standards and to be in conformity with the regulations in 2013. The requirements will be specified in regulatory resolutions in 2013, and an ASN guide should help clarify the regulatory requirements.

**Monitoring the projects to develop European regulations concerning radioactive substance carriers**

With regard to regulatory matters, 2012 saw the European Commission adopt a draft regulation aiming at instituting a system for registering radioactive substance carriers. This unique registration system, if ratified, will replace the national
CHAPTER 11

TRANSPORT OF RADIOACTIVE SUBSTANCES

Notification and licensing procedures stemming from application of the Directive 96/29 Euratom and transcribed in France by Article R.1333-44 of the Public Health Code. The Council of European Ministers has not yet given its decision on this regulation. In 2013, ASN will contribute to the European discussions in this area and the development of a French stance on the draft regulation.

Continuation of inspections of packages that are not subject to ASN approval

Compliance with regulatory requirements with regard to the transport of packages that are not subject to approval (see point 3) is improving in ASN’s opinion. Back in 2007 ASN asked for them to be brought into compliance with the regulations before the end of 2010. The recent inspections carried out by ASN have shown that the demands made during the inspections covering the 2008-2010 period, particularly regarding the content of the package design conformity justification file, have been taken into account; there are however still cases where this file is inexistent or incomplete.

It is moreover noteworthy that when the safety demonstration for a package design cannot be provided (notably with the ISO containers used in type-A packages), the entities concerned downgrade their package to a design that is less demanding in terms of safety. In 2013, ASN will endeavour to check that such downgrading is appropriate for the radioactive substances transported and does not call into question the safety of transport.

The additional inspection of the organisations that assist the packaging suppliers in preparing the package conformity files and certificates will also remain one of ASN’s concerns in 2013.

Continuation of inspections in the manufacture and maintenance of transport packages subject to ASN approval

The design of transport packages requiring ASN approval is inspected in depth during the examination of the approval request. Once ascertained that the package design complies with the regulatory requirements, its manufacture and subsequent routine maintenance in accordance with the requirements of its safety file must be verified. ASN has planned to maintain a large number of inspections in this area in 2013, particularly with regard to the maintenance of the oldest packagings.

Improvement in emergency situation preparedness and experience feedback from the Fukushima accident in the field of transport

ASN has led an initiative to draw up a guide to the drafting of emergency plans intended for the entities responsible for transport. A consolidated draft guide on which the stakeholders expressed their opinions was completed in 2012. The aim of final version of this guide, which could be published in 2013, is to harmonise and improve the practices of those responsible for transport in this area.

The Ministry of the Interior and the major stakeholders of the French nuclear industry are moreover looking into the management of emergency situations resulting from a transport accident to improve the national response should such an event arise.

ASN also wishes to draw all the possible lessons that the Fukushima accident can bring in the field of transport. Reflections on how to better evaluate the margins existing in the design of transport packagings were initiated in 2012, with a view to preventing the consequences of any type of event, even highly improbable, that could affect them, whether on the public highway or within the BNIs. In 2013, applicants will be asked to define a methodology for deciding whether improvements to approved packages are necessary in order to ensure their integrity in the event of a very-low-probability accident. The methodology chosen by the applicants will be examined by the members of the Advisory Committee for transport and by the Transport Safety Commission.

Transparency in the area of transport

Growing public and media interest in the transport of radioactive substances was observed for several international shipments organised in 2011. Consequently, ASN has made it a priority to develop the information made available to the public concerning the regulating of the safety of transport of radioactive substances. An educational file and a film were put on line on www.asn.fr at the end of 2011. The Contrôle review No. 193 published in March 2012 was devoted to the safety of transport of radioactive substances. This issue reviews the progress made since 2006, assesses the current situation of the issues, particularly technical and regulatory, and sets out prospects of actions at national and international level for the coming years.

ASN will moreover ensure that the requirements under Article L. 125-10 indicating that the person responsible for transport must communicate the information requested by a citizen, are also correctly applied in the radioactive substance transport sector.