ASNR Autorité de sûreté nucléaire et de radioprotection

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REPORT

Significant transport events reported to the ASN[1] over the 2021-2024 period

Statistics, key events and lessons learned

[1] The French Nuclear Safety Authority, which became the French Authority for Nuclear Safety and Radiation Protection (ASNR) on 1st January 2025.

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1. INTRODUCTION

To prevent accidents involving dangerous goods (including radioactive substances), the transport of dangerous goods is subject to international regulations that are incorporated into French law, with certain specific national provisions, where applicable. The prevention of transport accidents is based particularly on the technical measures (robustness of the package, stowage, etc.) and organisational measures (training of people in charge of transporting dangerous goods, safety instructions, appointment of a dangerous goods safety adviser (DGSA) in companies that load, unload or transport dangerous goods, etc.) required by the regulations.

Around one million packages containing radioactive substances are transported across France every year. Under the regulations[2], the French Nuclear Safety and Radiation Protection Authority (ASNR[3]) must be notified of any event with actual or potential consequences for the protection of the interests mentioned in Article L. 593-1 of the French Environment Code (i.e. public health and safety or the protection of nature and the environment).

The practical procedures for reporting these events are described in ASNR Guide 31, which defines, in particular, the seven criteria for declaring a transport incident. It also provides information about using the ASNR's on-line events notification service to report events (within four working days[4]), as well as the on-line service for submitting the Significant Event Report (CRES) (no later than two months after reporting the event).

The aim of reporting these events is to improve safety during the transport of radioactive substances by learning from past mistakes and sharing the lessons learned and good practices identified. Detecting and analysing these events not only contributes to the feedback process, but also makes it possible to:

- prevent identical or similar events from occurring again, by taking appropriate corrective and preventive measures;
- prevent a more serious situation from occurring by analysing the potential consequences of events which could foreshadow more serious events;
- identify the best practices to be promoted in order to improve transport safety.

This report:

- presents the lessons learned from significant transport events reported to the French Nuclear Safety Authority between 2021 and 2024, as well as a reminder of the applicable regulatory requirements or associated recommendations (chapter 2);
- looks into some of the key events that occurred over this period (chapter 3);
- provides statistics on significant events reported over this period (annex).

[2] Article L. 591-5 of the French Environment Code – paragraph 1.8.5 of the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), of the Regulations concerning the International Carriage of Dangerous Goods by Rail (RID) and of the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) – Article 7 of the TMD Order – ICAO Technical Instructions (chapter 7 of Part 1 and chapters 4.4 and 4.5 of Part 7).

[3] On 1st January 2025, the French Authority for Nuclear Safety and Radiation Protection (ASNR) succeeded the French Nuclear Safety Authority (ASN).

[4] 48 hours for air transport.

2. LESSONS LEARNED FROM THE SIGNIFICANT TRANSPORT EVENTS REPORTED BETWEEN 2021 AND 2024

As the ADR[5], and in particular, sub-section 1.4.1.1 states: *"the participants in the carriage of dangerous goods* [including the consignor and the carrier] *shall take appropriate measures according to the nature and the extent of foreseeable dangers, so as to avoid damage or injury and, if necessary, to minimise their effects*. *They shall, in all events, comply with the requirements of the ADR in their respective fields."*

These specific responsibilities include:

- firstly, the consignor of the dangerous goods is required to hand over for carriage only consignments which conform to the requirements of the ADR (sub-section 1.4.2.1.1 ADR);
- secondly, the carrier must ascertain that the dangerous goods to be transported are authorised for carriage in accordance with the ADR, and that the vehicles and loads have no obvious defects, leakages or cracks (sub-section 1.4.2.2.1 ADR).

The overall analysis, shown below, of the **361 significant transport events (STE) reported over the 2021-2024 period** underlines the fact that these responsibilities are not always assumed. These events also provide the opportunity to remind people of certain regulatory requirements.

2.1. ROAD ACCIDENTS

Despite the fact that the vast majority of transport is carried out by road, **road accidents only accounted for around 4% of the events reported to the ASN over the 2021-2024 period. These accidents are mainly attributable to loss of control of the vehicle as a result of the driver falling asleep, or failure to comply with the French Highway Code**. Therefore, most of these accidents could have been avoided.

Complying with the regulation governing the transport of radioactive substances does not exempt drivers from also complying with the French Highway Code, or to put it more precisely – these two regulations **complement** each other. The aim of the TMD Order is to prevent risks to people, property and the environment, alongside other regulations such as those aimed at protecting workers and consumers.

The analysis of the events particularly highlights the need to remind people of the rules of common sense that all vehicle drivers, whether or not they are transporting radioactive substances, should observe. It is particularly important that drivers:

- are in possession of:
  - a valid driving licence. The employer may ask the employee to prove that their driving licence is still valid at any time (Articles L. 1221-6 to L. 1221-9 of the French Labour Code, Article L. 223-7 of the French Highway Code);
  - a well-maintained vehicle (regularly serviced with an up-to-date MOT);

[5] Agreement concerning the International Carriage of Dangerous Goods by Road.

- respect:
  - the speed limits and safety distances, especially in bad weather;
  - the need to take breaks to avoid falling asleep at the wheel.

    Regulation (EC) no. 561/2006, applicable to drivers of vehicles over 3.5 tonnes, specifies that drivers must take a 45-minute break after driving for 4.5 hours. As far as light road transport is concerned, an employee may not work for more than 6 hours in a row without taking a break of at least 30 minutes.

    The French road safety guide recommends taking a break every 2 hours. This can prompt drivers to consider how best to split up long journeys by taking breaks;
- do not drive with a blood alcohol content of 0.50 g/l or more;
- do not look at their mobile phone or tablet while driving.

Carriers must also be in possession of a valid transport licence.

2.2. TRANSPORT CONDITIONS

Close to 6.5% of the significant transport events reported over the 2021-2024 period were caused by the conditions in which the transport took place. This included:

- the use of perforated or deformed containers during transport (reported in almost 74% of cases);
- the presence of a radioactive package on the passenger seat (mentioned in 9% of cases);
- the presence of an unauthorized passenger in the vehicle delivering the radioactive substances, including a child (almost 9% of cases);
- the use, by one carrier, of a vehicle without placarding to transport radioactive packages.

In accordance with the ADR, in particular chapters 7.5 and 8.1:

- upon arrival at the place of loading and unloading, [...], the vehicle and its crew members and, where appropriate, the container(s), [...], shall comply with the regulatory provisions (especially those concerning safety, security, cleanliness and satisfactory operation of the equipment used during loading and unloading);
- the transport vehicle must be structurally fit for use, i.e. it must not have any major defects affecting its structural elements, such as any damage that could affect its integrity (kinks, cracks, breaks, etc.), broken door seals, etc.;
- all transport units containing dangerous goods shall display orange plates on the transport unit and hazard labels on packages. The aim of this is to inform the emergency services of the nature of the load being transported, in the event of an accident.

The number of people exposed to ionising radiation due to their presence in the transport unit (vehicle) should be kept to a minimum. In particular, in accordance with chapters 7.5, 8.3 and 8.5 of the ADR:

- packages or overpacks of category II-YELLOW or III-YELLOW may not be carried in compartments occupied by passengers, except for compartments reserved exclusively for conveyors specially authorised to accompany such packages or overpacks;
- apart from crew members, it is forbidden to carry passengers in transport units transporting dangerous goods. Although, according to the ADR, this provision is not strictly applicable to excepted packages classed as UN 2908, 2909, 2910 and 2911, or to packages with category I-WHITE labels, in terms of radiation protection and the ALARA principle[6], the transport of passengers in a vehicle containing radioactive substances is to be prohibited.

These provisions are also supplemented by the TMD Order[7] which specifies, in particular, that packages must be placed either on the floor of the vehicle, or in racks attached to, or placed in, the load compartment, and that no dangerous goods may be placed in a compartment or box intended for transporting equipment (tools, pallets, etc.) other than cargo, in order to avoid discovering packages of radioactive substances in the hatches located under the floor of a truck.

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2.3. DELIVERY ERRORS AND STORAGE OF PACKAGES IN INAPPROPRIATE PLACES

Over the 2021-2024 period, problems relating to the traceability of radioactive packages accounted for just over 18% of the events reported. In almost 90% of cases, packages were switched during delivery to the consignees. This category also includes accidental discoveries of radioactive packages, either in private homes (for example, in the basement of a block of flats) or on public roads (often following a theft from a vehicle parked in a public car park).

These situations are mainly caused by failure to comply with delivery procedures or a lack of vigilance on the part of the person preparing the package (the consignor or external party) or the carrier. Therefore, most of the events reported could have been avoided by more rigorous application of the procedures and greater vigilance on the part of everyone involved in the shipment and delivery process.

In accordance with paragraph 1.7.3 of the ADR, and in order to ensure the safe transport of radioactive substances, a quality management system must be set up and applied by all participants involved in transport and to all activities related to transport operations.

ASNR Guide 44 sets out the ASNR's expectations regarding the content, maintenance and implementation of such a quality management system. As far as implementation is concerned, the guide reminds companies of the need to take steps to ensure that their staff, as well as external participants, are aware of the responsibilities incumbent upon them when implementing the quality management system.

[6] "As Low As Reasonably Achievable".

[7] Order of 29 May 2009, amended, concerning the transport of dangerous goods by land.

With regard to the in-transit parking of vehicles containing packages of radioactive substances, section 8.4 of the ADR stipulates that vehicles must be parked:

- (in order of priority) in a car park:
  - that is supervised by an attendant who has been notified of the nature of the load and the whereabouts of the driver;
  - (whether public or private) in which there is likely no risk of the vehicle being damaged by other vehicles;
- failing this, in a suitable, open space, located at a distance away from main roads and private residences, where the public does not normally pass or assemble.

In addition, Annex I of the TMD Order specifies that:

- in built-up areas, parking for more than 12 hours is prohibited;
- outside of built-up areas, vehicles must be parked at least 50 m away from any residence or establishment open to the public.

2.4. TRANSPORT OF GAMMA RAY PROJECTORS

Three main types of gamma ray projectors[8] are transported in France:

- GAM 80 – 120, the majority of models;
- GR 30 – GR 50; and
- GAM 400.

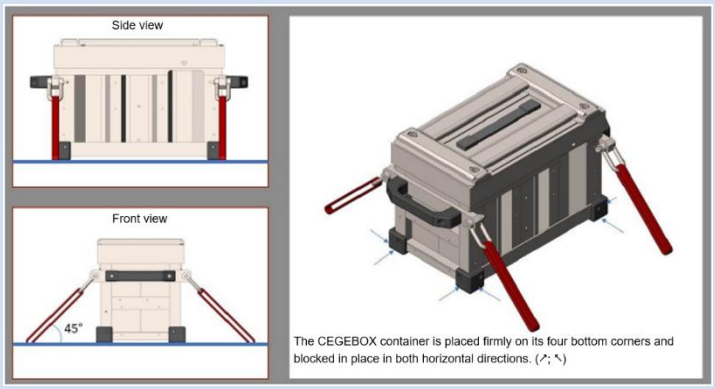
Over the 2021-2024 period, just over 8.5% of the significant events reported concerned the transport of gamma ray projectors. There were two main reasons for these notifications:

- incorrect labelling of packages (almost half of all the events), often inconsistent with the transport documents;
- transport (and in particular stowage) conditions not complying with the requirements of the certificate of approval for package design (consisting of the gamma ray projector itself and its Cegebox in general), which accounted for almost 20% of the events reported.

GAM 80 and 120 devices must be placed in a CEGEBOX for transport purposes. It is the entire package (gamma ray projector + CEGEBOX) that constitutes the transport package. This package design is currently covered by approval certificate F/398/B(U)-96 (Dm), valid until 30 September 2027. Its requirements are based on the Package Design Safety Report (PDSR) supplied by the designer.

[8] Portable industrial radiography equipment used for non-destructive testing.

In terms of stowage, based on the manufacturer's instructions for use, the certificate of approval requires the use of 4 straps (the Working Load Limit (WLL) of which is at least 2,000 kg) attached to four shackles positioned in the four corners of the package, and forming an angle of 45° with the floor. The longitudinal axis of the Cegebox must face in the same direction as the direction in which the vehicle is moving. The Cegebox must also be secured in place to prevent it from moving around on the floor of the vehicle.



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2.5. RADIATION PROTECTION

Since 2021, there have been no reports of any cases exceeding the regulatory dose limit of 20 mSv over twelve consecutive months, as set by the French Labour Code. This is a positive development in comparison to previous years. Between 2018 and 2020, the exposure to ionising radiation of certain drivers working in the medical sector (transport of radiopharmaceuticals, in particular) had exceeded the regulatory limit.

In addition, in come cases, certain categories of drivers (within the meaning of Article R. 4451-57 of the French Labour Code) did not wear their delayed-reading dosimeter (otherwise known as a “passive” dosimeter).

Finally – and most importantly – the three principles of radiation protection (justification, optimisation and radiation dose limitation) were not understood by some drivers, despite having completed theoretical training in the risks inherent in exposure to ionising radiation. The unjustified exposure of a child or the transport of a package on a passenger seat, listed below as some of the key events of the 2021-2024 period, are reminders of the fact that application of the basic rules of radiation protection calls for vigilance to be exercised on a daily basis by everyone involved, from the training staff and employer, to the radiation protection advisor and driver.

Professionals exercising a radioactive substance transport activity can find recommendations relating to the radiation protection of workers and the public in ASNR Guide 29. This guide deals, in particular, with the link between French legislation (the French Labour Code and the French Public Health Code) and international regulations (modal regulations).

Over the 2021-2024 period, 20% of the significant events reported involved contamination or dose rates on packages or in vehicles exceeding the limits set by the modal regulations. Some of these cases of non-compliance were detected following the entry into force of the Order of 23 October 2020, which mandates periodic verifications of the radiological cleanliness of vehicles (Articles 14 and 15 of the Order).

Of these events, just over 30% mentioned surface contamination in a wagon that had transported a package containing spent fuel. In all the cases reported, the area concerned was not accessible during transport.

Radiological cleanliness must be checked systematically prior to undertaking the carriage operation, and periodically upon receipt of the packages.

As we have already seen, sub-section 1.4.2.1.1 of the ADR states that the consignor has primary responsibility for ensuring transport safety. Therefore, it is the consignor's responsibility to provide the carrier with a package that complies with the regulations. To ensure this, pre-shipment checks must be carried out, particularly with regards to contamination on the external surfaces of the package (sub-sections 2.2.7.1.2 and 4.1.9.1.2 of the ADR).

In addition, periodic verifications of radiological cleanliness must be carried out on the transport units in accordance with the provisions of Articles R. 4451-44 to R. 4451-47 of the French labour code.

ASNR Guide 29 sets out the ASNR's expectations in terms of periodic inspections of packages and transport units.

2.6. MALICIOUS ACTS

Actual or attempted malicious acts are covered by criterion 2 in ASNR Guide 31, although most thefts of sources or equipment containing sources are more likely to be considered a significant radiation protection event (ESR), rather than a significant transport event.

The Order of 29 November 2019[9] specifies the technical and organisational measures that must be implemented to ensure the safety of radioactive sources, both within facilities and during transport operations. When category A, B or C sources (high-activity sealed sources or HASS) are transported, in application of Articles 17 and 18 of the Order, the carrier must prevent, detect and report any malicious incidents in which the vehicles are involved. It must, for example, have a plan for managing these events.

Although none of the transport events reported to the ASN over the 2021-2024 period involved high activity sealed sources (HASS), several events were related to attempted break-ins of drivers' vehicles, or thefts of equipment containing radioactive sources.

Drivers must choose vehicle parking areas that do not facilitate break-in attempts. The ADR also sets out selection criteria in this area (see box above). The Order of 29 November 2019 lays down additional requirements if the transport operation involves category A, B or C radioactive sources.

2.7. DAMAGE TO PACKAGES AND CONTAINERS

Close to 4% of the significant events reported over the 2021-2024 period were due to packages or containers being damaged during the transport phase. For example, this could be the result of a package or container falling or being crushed by a forklift truck or impaled by the forks of a forklift truck during handling.

All participants involved in transporting radioactive substances must take their share of responsibility to ensure that the package is transported correctly. A number of good practices can be highlighted to prevent such damage:

- provide sufficient space for storing packages or containers, even temporarily, so that forklift trucks can move between them and carry out handling tasks without obstruction;
- limit the speed of vehicles in storage, loading and unloading areas;
- train the teams concerned in correct stowage methods and compliance with stowage plans;
- for certain types of package, in particular those that are bulky, organise ("pre-job briefing"-type) preparation meetings and hold points in order to make actions more reliable;
- give operators clear and precise instructions. In this respect, it can be useful to take "human and organisational factors (HOF)" into account when drawing up these instructions.

[9] Order concerning the protection of ionising radiation sources and batches of radioactive sources of categories A, B, C and D against malicious acts

As far as the loading and unloading of packages[10] is concerned:

- when picking up loads, ensure that the loads are balanced, stable and evenly secured to their supports to avoid any risk of them slipping or tipping over;
- insert the fork arms under the loads, lift gently and immediately tilt the boom (or fork arms) backwards;
- if the load is large, make sure that it cannot slide off the forks;
- In the case of liquid contents, if the container is not completely full, precautions must be taken to prevent it from tipping over (instability of the load);
- choose the right equipment for transporting pallets or IBCs: a pallet truck should be used if the mounting slots allow the fork arms to be inserted, and a forklift truck if this is not the case.

Figure 1 – Pallet truck (left) and forklift truck (right).

In accordance with the Order of 2 December 1998 relating to the training and operation of self-propelled mobile work equipment and equipment for lifting loads or people, "*in order to drive self-propelled handling gear with a ride-on operator, workers must hold a driving licence, drawn up and issued by the head of the establishment, based on an assessment carried out by the latter.*

This assessment, which is designed to establish that the worker is fit and able to operate the equipment for which the authorisation is being considered, takes the following three elements into account:

- *an aptitude test carried out by the occupational physician;*
- ***a test of the operator's knowledge and skills in driving the work equipment safely***[11]*;*
- ***knowledge of the area and the instructions to be followed at the site(s) of use.***"

2.8. STOWING RADIOACTIVE PACKAGES AND OTHER EQUIPMENT

Close to 7% of the significant events reported over the 2021-2024 period were caused by a failure to secure or prevent packages from moving around in their transport units.

A quarter of these events concerned failure to comply with the stowage requirements stipulated in the certificate of approval of the gamma radiography package designs (CEGEBOX 400 and CEGEBOX GAM 80-120 – see above).

The remaining events involved cases of failure to comply with the instructions of the transport company (or the forwarding agent, in the case of very small companies).

[10] See INRS guide ED 766 Chariots automoteurs de manutention – Manuel de conduite (Self-propelled industrial trucks – Driver's manual).

[11] Validated by obtaining the *Certificat d'aptitude à la conduite en sécurité* – Certificate of Aptitude for Safe Driving (CACES).

Consequently, these types of event could have been avoided through better knowledge of the instructions and by taking a more rigorous approach in applying them[12].

In accordance with section 7.5.7 of the ADR, "***packages containing dangerous substances and unpackaged dangerous articles shall be secured by suitable means capable of restraining the goods (such as fastening straps, sliding slatboards, adjustable brackets) in the vehicle or container in a manner that will prevent any movement during carriage which would change the orientation of the packages or cause them to be damaged. When dangerous goods are carried with other goods (...), all goods shall be securely fixed or packed in the vehicles or containers so as to prevent the release of dangerous goods. Movement of packages may also be prevented by filling any voids by the use of dunnage or by blocking and bracing. Where restraints such as banding or straps are used, these shall not be over-tightened to cause damage or deformation of the package. The requirements of this paragraph are deemed to be complied with if the cargo is secured in accordance with standard EN 12195-1:2010.***"

In addition, ASNR Guide 27 sets out the regulatory requirements and the Authority's recommendations on stowage. It mentions, in particular, the need to provide specific training for all persons involved in the design, implementation or inspection of the stowage.

2.9. INCORRECT PACKAGE CLASSIFICATION

Around 13% of the events reported over the 2021-2024 period relate to an error in the package classification, almost half of which concern excepted packages.

The main causes of these errors include:

- non-compliance with the internal procedure, in particular mandatory radiological checks to be carried out before the package leaves the country;
- the application of an unsuitable procedure for determining the maximum point of contact dose rate, combined with a failure to share feedback between the consignors and consignees of the packages;
- errors in calculating the transport index (TI) (in particular, failure to take account of the multiplication factor based on the size of the load as set out in sub-section 5.1.5.3 of the ADR);
- failure to comply with the conditions under which the source is packaged, resulting in the source being incorrectly wedged in place (so that it moves around within the packaging, reducing the distance between the source and the outer surface of the package);
- dose rate measurements, carried out upon departure of the package, using unsuitable, poorly sensitive or badly calibrated equipment, or with a high ambient radiological background. This can lead to underestimation of the TI.

Among the good practices observed in the Significant Event Reports (CRES), the following should be noted:

- organisation of:
  - tutoring for the individuals carrying out the measurements to ensure that they have mastered their activity;
  - double checking of the TI calculations;

[12] However, this is not specific to the transport of radioactive substances. According to estimates by the French National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases (INRS), every year in France, around 2,500 accidents are related to inadequate stowage, with between 80 and 135 people hospitalised and between 12 and 28 road users or professionals killed. An analysis of accidents involving stowage errors in road transport of all goods (HGVs with a permissible total weight exceeding 3.5 tonnes) carried out by the INRS in 2021, showed that, among the daily checks performed by DREAL staff, around 80% of the lashings checked did not comply with the requirements of standard EN 12195-1, and that, out of this 80%, 20% of the loads had no means of restraint at all.

- provision of:
  - tools to help calculate the TI;
  - measuring equipment adapted to the situations encountered (for example, a special pole for checking the underside of a container, a special gamma probe, etc.);
- changing the source packaging;
- taking into account the sensitivity of the dose rate meter when renewing the stock of measuring instruments;
- standardising the measurement method across all sites concerned.

Sub-section 5.1.5.3 of the ADR specifies the elements to be taken into account when determining the transport index for a package, an overpack or a container, etc.

The categories of packages, overpacks or containers are defined on the basis of the transport index, coupled with the maximum dose rate at any point on the external surface, in accordance with table 5.1.5.3.4 of the ADR as set out below:

Conditions		
TI	**Maximum dose rate at any point on the external surface**	**Category**
0[a]	Not more than 0.005 mSv/h	I-WHITE
More than 0 but not more than 1 [a]	More than 0.005 mSv/h but not more than 0.5 mSv/h	II-YELLOW
More than 1 but not more than 10	More than 0.5 mSv/h but not more than 2 mSv/h	III-YELLOW
More than 10	More than 2 mSv/h but not more than 10 mSv/h	III-YELLOW [b]

[a] *If the measured TI value is 0.05 or less, it may be rounded down to zero, in accordance with 5.1.5.3.1 c).*

[b] *Shall also be carried under exclusive use except for containers (see table D in 7.5.11 CV33 (3.3)).*

In addition, sub-section 1.4.2.1.1 of the ADR stipulates that the consignor has primary responsibility for ensuring transport safety. It is the consignor's responsibility to provide the carrier with a package that complies with the regulations.

3. A FEW KEY EVENTS DECLARED TO THE ASN BETWEEN 2021 AND 2024

3.1. ROAD ACCIDENTS

3.1.1. Road accident in Côte d'Or *department* due to the driver's blood alcohol content

In 2021, on the A31 motorway from Beaune to Nancy, near Prémeaux-Prissey in the Côte d'Or *department*, the mobile radiological response unit of the Departmental Fire and Rescue Service (SDIS) responded to an accident involving a heavy goods vehicle that was transporting a UN 2912 container (radioactive material, low specific activity (LSA-I), non-fissile) and a UN 3324 container (radioactive material, low specific activity (LSA-II), fissile) which contained slightly contaminated clothing. After hitting a bridge pile, the HGV jack-knifed and ended up crashing into the metal side barriers for several metres. The driver was slightly injured.

An investigation by the fire service showed that the containers were neither open nor damaged. The HGV was evacuated in the evening to a secure carrier site, 15 km from the accident site. The consignor picked up the containers the next day and took them to the processing site.

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The *Bureau d'enquêtes sur les accidents de transport terrestre – BEA-TT* (French Land Transport Accident Investigation Bureau) conducted investigations under the general angle of road safety/organisation of transport in order to identify the possible root causes of the accident (working hours, working conditions, etc.), fearing that the driver had fallen asleep. These investigations did not lead to an inquiry being launched.

In the end, it turns out that the driver was under the influence of alcohol.

3.1.2. Road accident in the Vosges *department* due to driver falling asleep

At the end of 2023, the Vosges Departmental Fire and Rescue Service (SDIS) informed the ASN that it was responding to a road accident on the A31 motorway, at Auzainvilliers near Vittel in the Vosges *department*, involving three type A packages containing Fluorine-18. The driver had fallen asleep at the wheel and crashed into the rear of the HGV in front of him. The driver was not injured, apart from complaining of a sore wrist.

The packages remained intact. The dose rate at 1 m from the vehicle was 10 µSv/h. The SDIS took smear samples to check that there had been no contamination in the vehicle.

3.2. DELIVERY ERRORS DUE TO TRAILERS BEING SWITCHED

At the end of 2023, a driver went to the consignor's site to hitch up a trailer that he had loaded two days earlier. This trailer was loaded with five FCC4 containers holding enriched natural uranium (ENU) fuel assemblies,

destined for a nuclear power plant. At the consignor's site, two identical trailers from the same carrier had been loaded with FCC containers containing fuel assemblies.

The error was not detected by the driver until he reached his destination. Checks carried out on departure from the consignor's site did not detect that the trailers had been switched. This event was caused due to:

- a period of high traffic at the guard post at the time that the vehicle was departing;
- the driver's habit of systematically preparing and collecting his trailer from the same place for many years. He was convinced that it was "his" trailer.

Following this incident, the list of checks to be carried out by drivers before setting off was revised, including checking the trailer's number plate.

3.3. EMPTY PACKAGE DISCOVERED IN THE BASEMENT OF A BLOCK OF FLATS

In mid-2022, a service company found an (empty) returned package of a Kryptoscan generator in the basement of a block of flats, which had been shipped by a hospital outside of the Paris area and was intended for a radiopharmaceutical supplier in the Ile-de-France region.

If the carrier's package dispatch procedure had been followed correctly, this package should have been deposited at the carrier's Ile-de-France storage site at the end of the driver's daily round. However, the driver had left the package in the vehicle to save himself a trip to the depot, despite the fact that he was starting annual leave that very evening. Three days later, the vehicle was used by a colleague who was unaware of the presence of the package. At the weekend, this driver lent the vehicle to a friend to pick up an item of furniture. On discovering the package when he opened the vehicle, this friend removed the package and put it in the basement of his block of flats to make room for the furniture in the vehicle's load compartment. Once the furniture had been transported, he forgot to return the package to the borrowed vehicle. Consequently, the package was never delivered to the depot, and was discovered in the basement several weeks later.

To prevent such incidents from re-occurring, all the transport company's drivers dedicated to class 7 packages were reminded that packages destined for and departing from depots must only be delivered to, and loaded at, the client's premises, and that no packages must remain in the vehicle when leaving the depot at the end of their rounds.

3.4. UNJUSTIFIED EXPOSURE TO IONISING RADIATION

3.4.1. Presence of a child next to a driver

In 2023, when a delivery driver arrived at a university hospital with a radioactive product (FDG – UN 2915 type A package), the manager of the hospital's PET Scan[13] department and the secretary noticed that there was a child in the delivery vehicle's cab.

When questioned, the driver argued that he had had to look after his child.

A warning was sent to the driver by his employer and he was reminded of the correct radiation protection rules.

3.4.2. Carrying a package on the passenger seat

In mid-2023, a driver arrived at the entrance to the consignor's site to pick up a technetium generator and take it to Roissy airport. Vehicles are supposed to arrive empty at this site, i.e. without any radioactive packages in the load compartment. However, that day, in order to replace a colleague and avoid an extra return trip to the hub, the driver had put the package next to him on the passenger seat of the driver's cab.

[13] Positron emission tomography.

After being detected, the package was returned to the loading area where it was stowed.

All the company's drivers were reminded of good practices when collecting packages.

3.5. FALLING PACKAGES

3.5.1. Fall of a package while being loaded onto a semi-trailer

In early 2023, while being handled in the storage area with a view to being loaded onto a truck, an FCC package containing fresh fuel fell about 1.50 m from the forklift's transport platform.

An analysis of the event showed that the main cause was poor adhesion of the package to the forklift's platform (due to the contact of steel against steel), coupled with:

- wear on the bearing surfaces of the forklift;
- a turning radius that was slightly too tight.

Actions taken to prevent such a fall from happening again included:

- installing a mechanical stop on the forklift's platforms to prevent FCCs from sliding;
- applying an anti-slip coating to the forklift's platforms.

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3.5.2. Fall of a technetium generator during loading on board an aircraft

At the end of 2023, several TEKCIS packages (Mo99/Tc99m generators) were placed on a conveyor belt for loading into the cargo hold of an aircraft. While on the conveyor belt, one of the radioactive packages collided with a package in front of it, and came to rest against the aircraft's door sill. As a result of the congestion caused, the package fell off the conveyor belt down to the ground, from a height of several metres.

This situation made it necessary to disembark the passengers from the aircraft and to set up a security perimeter around the loading area at the foot of the aircraft. The fire service carried out dose rate and contamination measurements and placed the package in vinyl wrapping. The package was then transferred to the airport's storage area for radioactive packages. A team from the company that had dispatched the package was called in to take charge of the package that had fallen, and return it to the consignor's establishment. No contamination was detected on the outside of the package.

As this was the first time that such an event had occurred, the ground crews were reminded of the need for vigilance when handling packages, particularly radioactive ones when loading them onto the aircraft.

3.5.3. Fall of an X-ray fluorescence machine transported on a motorbike on the A25 motorway

In April 2021, at around midnight, the ASN was informed, via its on-call system, of the loss of a radioactive source of cadmium-109, present in a paint lead detector. The device was being transported on a motorcycle, when the fastenings on the rear case gave way, causing it to fall onto the A25 motorway.

The driver noticed that he had lost the load when returning to the office, and informed the company manager. The two individuals retraced the driver's movements in the opposite direction and found the carrying case ripped open on the side of the motorway. The local fire service, which specialises in operations involving radiological risks, was contacted to search for the radioactive source. It was found undamaged and returned to its owner in a steel box.

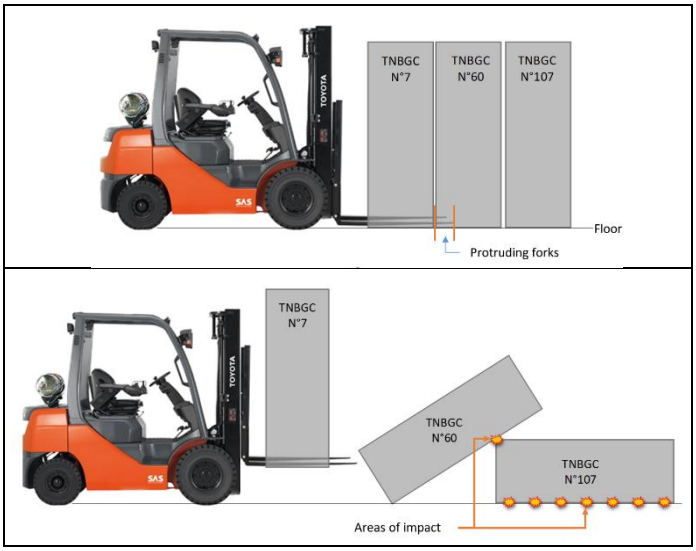
As a reminder, the transport by two-wheeled vehicles of this type of equipment (excepted package) is not prohibited. In accordance with Article 3.4.2 of the TMD Order, the use of two- or three-wheeled vehicles is prohibited for transporting materials and objects assigned to UN 3291 and UN 3549, as well as for transporting radioactive materials, except in the case of own-account transport of UN 2911 materials.

3.5.4. Fall of two TN-BGC packages during handling

An operation to load seven empty TN-BGC packages (classed under the UN2908 label) using a forklift truck was carried out in mid-2023. Three packages had been placed on the floor, one next to the other.

When lifting the first package, the forks of the forklift truck were inserted too far and protruded slightly from underneath the package, causing the other two TN-BGCs to fall over while the first package was being lifted. The third package ended up lying on the floor, while the one in the middle remained leaning against it, slightly damaging its protective cage.

Minor damage was noted on one of the packages.



3.6. NON-COMPLIANCE WITH PACKAGE TRANSPORTATION CONDITIONS

3.6.1. Receipt of a gamma ray projector from Africa

In 2024, a carrier took delivery of a gamma ray projector at Roissy-CDG airport which had been sent by a foreign branch of a French group, carrying out non-destructive testing, with a view to transporting the device to its manufacturer for maintenance and replacement of the source.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On receipt of the package at the manufacturer's, a number of non-conformities were noted:

- transport of the gamma ray projector (GAM) inside its "CEGEBOX" overpack, placed unsecured inside a basic wooden crate;
- no labelling on the wooden crate indicating the presence of a radioactive substance, and no other mandatory information as required by international regulations concerning the transport of radioactive materials;
- absence of any mention of the presence of a radioactive substance on the air waybill;
- absence of a dangerous goods declaration (DGD).

In addition, the maintenance on the GAM was 10 months overdue.

A similar event involving the same gamma ray projector had already occurred at the end of 2022.

An audit of the foreign subsidiary was carried out by the French group to assess its knowledge of the international rules governing the transport of radioactive substances, and a systematic check of compliance with safety regulations was requested prior to each shipment of a non-exempt radioactive source.

3.6.2. Multiple non-conformities during the transport of a gamma ray projector

In 2023, on receipt at the manufacturer's premises of a gamma ray projector dispatched by a non-destructive testing company, the following non-conformities were observed:

- no labelling on the CEGEBOX;
- incorrect vehicle placarding;
- maintenance date exceeded, rendering the package unfit for transport in accordance with its certificate of approval.

The consignor's analysis of the discrepancies showed that:

- the maintenance date had indeed been identified as having been exceeded and another package should have been used for transport. However, due to a communication problem between the participants involved, this was not followed through in the end;
- the placarding inconsistencies and the lack of labelling were brought about by carelessness on the part of the personnel involved in preparing the transport.

The corrective measures put in place involved updating the transport preparation procedures in order to clarify and track the actions to be taken by each party involved.

3.6.3. Absence of seals, and leaks in the first containment barrier

Two foreign non-destructive testing companies used a UKI 4-135 type B(U) package with Czech approval certificate CZ/005/B(U). This package consisted of a cylindrical container (photo on the left below), sealed with 6 nuts, in which had been placed a second reinforced container (photo on the right below) capable of holding a maximum of 4 sources of special form iridium-192. This second container was being used to transfer sources to a gamma ray projector.

Figure 2 – Cask body (left) and inner container (right).

Three significant events (all reported in 2022) were related to the use of this package:

- the first stemmed from the absence of a seal on the package;
- the second concerned two discrepancies: the absence of a seal on the package and the loosening of the nuts on the lid of the cylindrical container;
- the final event concerned the absence of a seal on the package and the loss of 5 out of 6 of the nuts (see photo opposite).

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There were no significant consequences for workers, the public or the environment because:

- the radioactive sources transported were disused sources with low residual activity;
- the inner container had remained sealed and undamaged inside the cask body;
- no other damage had occurred on the cask body;
- at a distance of more than one metre from the package, the dose rates measured were negligible.

ANNEX

STATISTICS ON THE SIGNIFICANT EVENTS REPORTED TO THE ASN BETWEEN 2021 AND 2024 21

APPENDIX - Statistics on the significant events[14] reported to the ASN between 2021 and 2024

1.1. General

The reporting of significant events to the ASN is not specific to the transport sector.

Over the 2021-2024 period, several thousand events – from all sectors – were reported and, where appropriate, rated on the INES scale (table 1 and figure 3).

Year	Basic Nuclear Installations				Small-scale nuclear activities (medical and industrial)				Transport of radioactive substances		
	INES 0	INES 1	INES 2	Total	INES 0	INES 1	INES 2	Total	INES 0	INES 1	Total
2021	1068	103	1	**1172**	177	33	0	**210**	80	4	**84**
2022	985	97	0	**1082**	163	37	2	**202**	76	12	**88**
2023	1010	86	2	**1098**	176	25	0	**201**	84	2	**86**
2024	1047	75	2	**1124**	210	21	0	**231**	100	3	**103**

Table 1 – Number of significant events, from all sectors, reported to the ASN between 2021 and 2024 (source: ASN report on the state of nuclear safety and radiation protection in France in 2024).

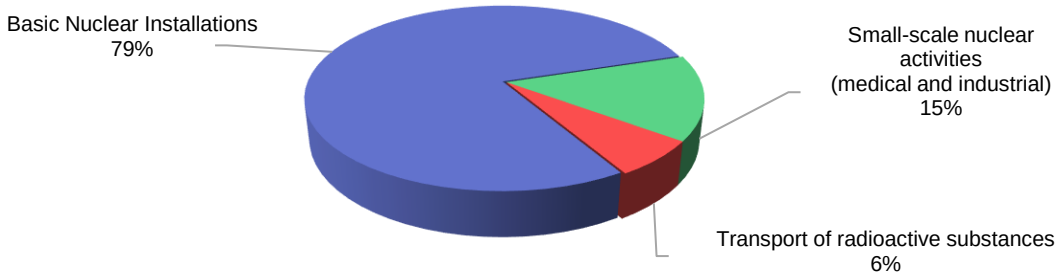

Figure 3 – Breakdown of the number of significant events over the 2021-2024 period, by business sector.

With regard, more specifically, to transport (figure 4), 361 events were recorded over the 2021-2024 period, i.e. 6.4% of the significant events reported during this period. 21 events were rated level 1 on the INES scale, with an annual average of 82 significant events rated INES 0. This figure remained fairly stable from the introduction, in 2019, of the ASN's on-line events notification service, until 2023.

In 2024, there was a slight increase in the number of notifications, reflecting the growing awareness among transport operators of the requirement and obligation to report a significant event.

[14] This document only considers significant events relating to transport on public roads.

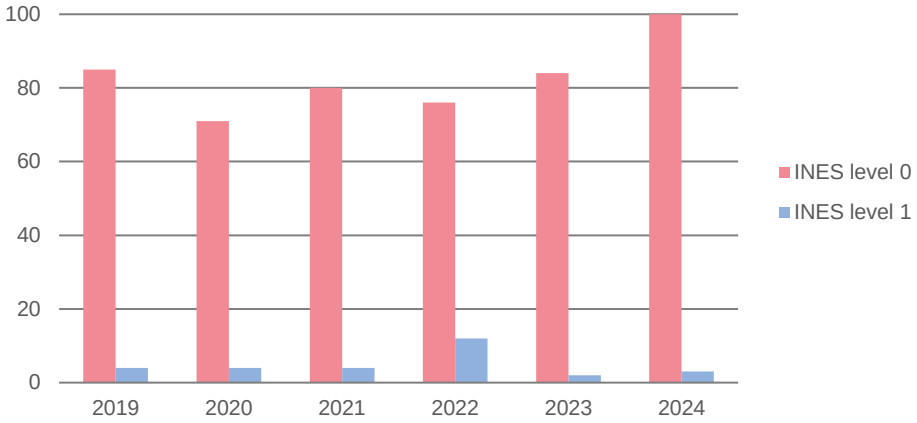

Figure 4 – Trend in the number of STE reported since the ASN's on-line events notification service was set up, according to the INES level reported.

1.2. Locations in which the events were detected

An analysis of the locations in which the significant transport events were detected in 2018 showed that this was mainly in the Ile-de-France region and on the A6 and A7 motorways.

Since then, the detection sites have become much more varied and consistent with the volumes of radioactive substances being transported on public roads, whether this involves transport relating to the fuel cycle, transport of radiopharmaceutical products between suppliers and the various hospitals in France, or transport of sources for industrial purposes, as well as transport abroad.

Figure 5 below shows that, during the 2021-2024 period, significant events reported to the ASN were detected abroad in Germany (2), Australia (1), Finland (1), Italy (1), Luxembourg (1), the Netherlands (1), the United States (1) and even Taiwan (1)! However, these events represent less than 3% of those reported.

This reflects a marked improvement in the attention paid by transport operators (including foreign operators) to the conditions under which they carry out their transport activities, the detection of non-conformities and the reporting of significant events.

With regard to the events that occurred in France, the main areas in which events were detected over the 2021-2024 period were:

- the southern half of France – mainly around the major motorways (the A62 motorway between Toulouse and Bordeaux/the A7 motorway), and along the Mediterranean coast;
- the northern half of France – no particular sector dominated in the north-east; mainly major routes to and from nuclear power stations, and along the coast of the Manche *département*.

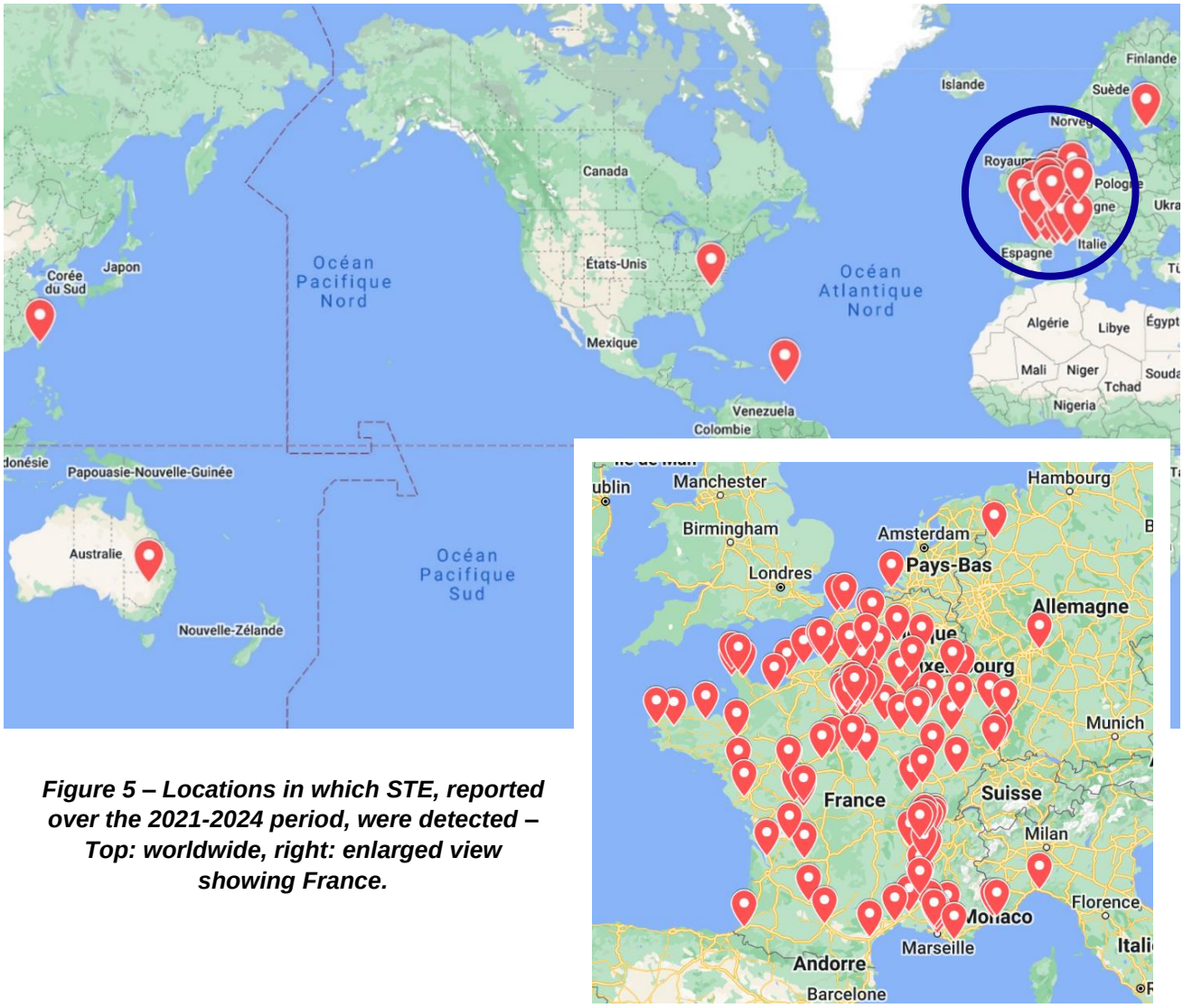

Figure 5 – Locations in which STE, reported over the 2021-2024 period, were detected – Top: worldwide, right: enlarged view showing France.

1.3. Modes of transport involved per event

In France, road transport is by far the most common mode of transport used to carry radioactive substances. Therefore, it is logical that it should account for approx. 80% of the events reported (depending on the year) over the 2021-2024 period.

In terms of rail transport, the events mainly concerned contamination detected in part of the drainage sump of a railcar that was transporting a spent fuel package from a nuclear power plant (EDF nuclear power plant). This is also consistent with the volumes of transport, as rail transport is only used within the context of the fuel cycle.

With regard to air transport, the events reported mainly concern damage to radiopharmaceutical packages during handling in cargo areas, and non-compliance with the certificate of approval for transporting gamma ray projectors.

A few events related to maritime transport were also reported. These involved contamination of drums loaded with uranium compounds from abroad. However, a decrease in these events has recently been observed thanks to actions being taken at the request of French customers to foreign mining consignors, to reinforce pre-shipment checks, and enforce a second-level sampling check by French manufacturers at shipping sites.

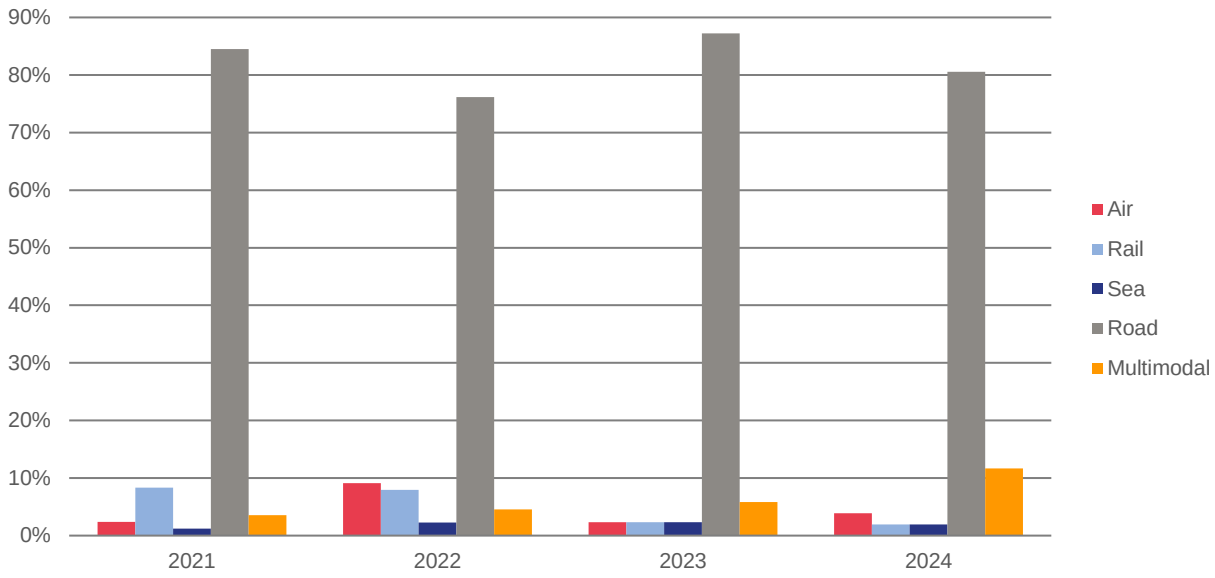

Figure 6 – Breakdown of STE reported by mode of transport for the period studied.

1.4. Types of package involved in the transport event

A package is defined as packaging that contains a radioactive material[15]. Transport safety depends, first and foremost, on the robustness of the package. The more dangerous the contents being transported, the more the package must be able to withstand severe accidents. Different types of package exist, depending on how dangerous the contents are:

- **Excepted packages:** this is the type of radioactive package with the lowest safety risk. The total activity (Bq) of the materials contained is low. There are few regulatory requirements to be complied with.
- **Industrial packages (type IP-1, IP-2, IP-3):** this type of package was created in the regulations to enable the transportation of large quantities of materials, the total activity (Bq) of which may be high due to the mass of materials contained, but the specific activity (Bq/g) of which is low. The risk posed by these materials is limited because the total activity cannot be concentrated into a small volume. Two types of substance are transported in this type of package: Low Specific Activity (LSA) materials and Surface Contaminated Objects (SCO).
- **Type A packages:** a type A package has a safety level equivalent to that of a type IP-3 package. It can be used to transport any substance with an activity of less than 1_{A2} (or 1_{A1} if it comes in a special form). The consequences of destroying a type A package would remain limited in scale and scope.
- **Type B packages:** type B packages are capable of withstanding severe accidents – a characteristic that guarantees a high level of safety. As such, these packages must be approved by a competent authority (the ASNR in France) before they can be used.

The table below identifies the sectors of activity in which the different types of package are mainly used for transporting radioactive substances:

[15] It should be noted that “exempt materials”, which are radioactive substances with radioactive levels deemed to be too low to present a risk, are not subject to the regulations governing the transport of radioactive substances.

	Fuel cycle	Medical	Non-nuclear industry	Research
Excepted packages		✓	✓	✓
Industrial packages	✓			
Type A packages		✓	✓	✓
Type B packages	✓		✓	✓

As far as the 2021-2024 period is concerned, figure 7 shows that the packages most affected by the significant events reported were type A packages, closely followed by industrial packages and type B packages.

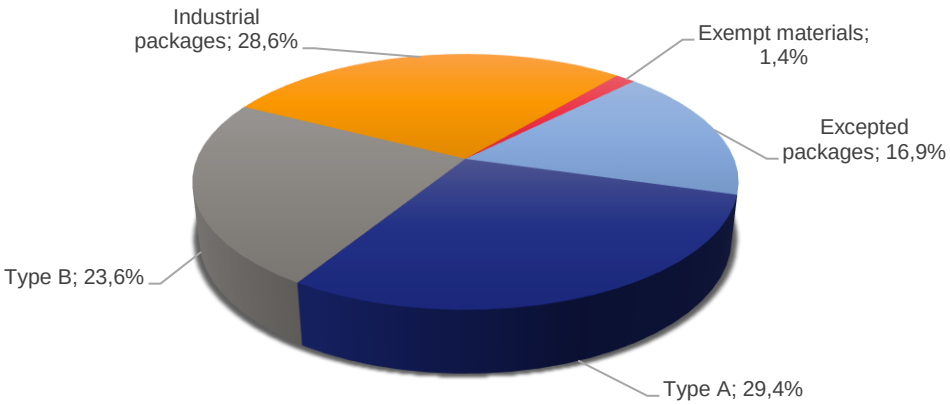

Figure 7 – Breakdown of STE by type of package, over the 2021-2024 period.

Looking at each year individually (figure 8), the breakdown remains fairly similar to that shown in figure 6.

In 2021, there were fewer events involving type A packages. This type of package is mainly used for transport of radiopharmaceutical products, known to be carried out by small companies, or even one-person companies, which were not in the habit of reporting events if any deviations occur. This situation has significantly improved as a result of the information provided by the ASN, particularly to freight forwarders who have close contacts with this type of company.

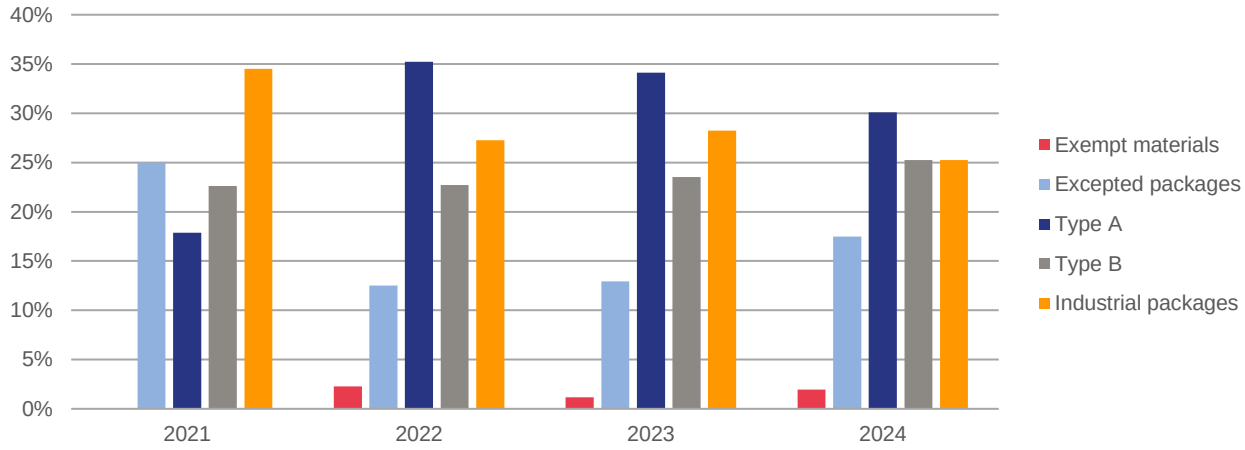

Figure 8 – Breakdown of STE by type of package and by year, over the 2021-2024 period.

1.5. Package contents and business sectors concerned

The breakdown, by activity sector, of the number of significant events reported (figure 9) highlights significant differences between the nuclear industry (the nuclear fuel cycle, including BNIs) and what are known as “small-scale” nuclear activities (the medical sector, the non-nuclear industry and research). More than half of the events reported concern the fuel cycle sector. This trend can be explained by the more systematic approach taken by transport operators in this sector to search for, detect and report incidents.

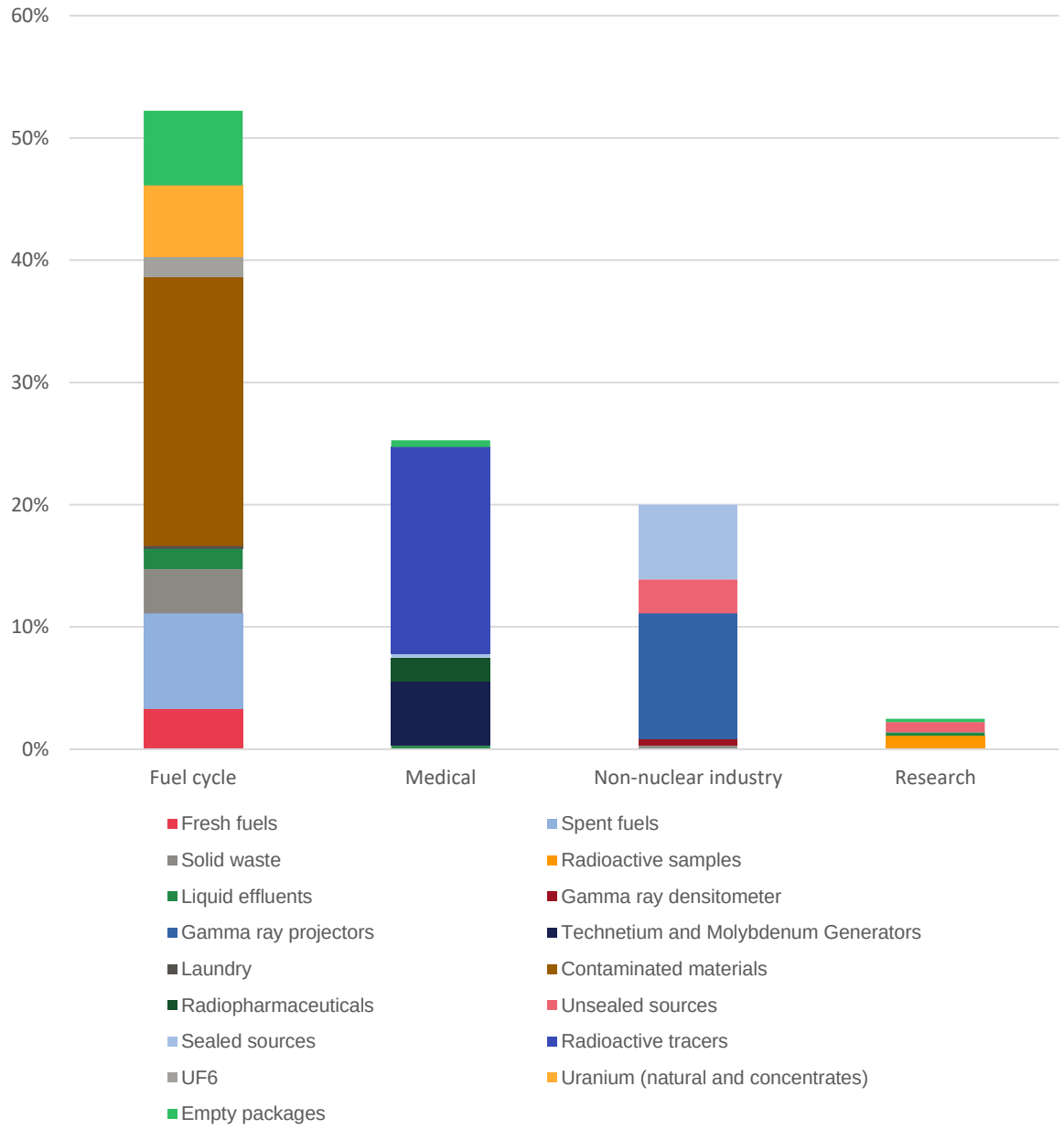

Figure 9 – Breakdown of STE by activity sector and type of content over the 2021-2024 period.

Figure 9 also shows that:

- most nuclear industry incidents involve contaminated materials or spent nuclear fuel;
- for small-scale nuclear activities, this involves:
  - in the non-nuclear industry, the transport of gamma ray projectors;

- in the medical sector, fluorine-18 (radioactive tracer).

1.6. Breakdown of events by notification criteria

ASNR Guide 31 defines seven criteria that lead to an event being deemed significant in terms of affecting transport safety and therefore:

- being reported to the ASNR;
- being the subject of an analysis (via the Significant Event Report – CRES) which must be sent to the ASNR so that all the lessons learned can be drawn from it.

1.6.1. Notification criterion

The significant events reported over the 2021-2024 period mainly consisted of events involving non-compliance with a regulatory requirement (notification criterion 5, as defined in ASNR Guide 31) or exceeding the dose rate or contamination limits (criterion 3) (figure 10).

Among them, package classification errors are a major reason for reporting significant events (over 33%). They are often due to errors in radiological measurements, most of which lead to an underestimation of the category of package, which can ultimately hinder the effective management of an incident/accident involving such packages.

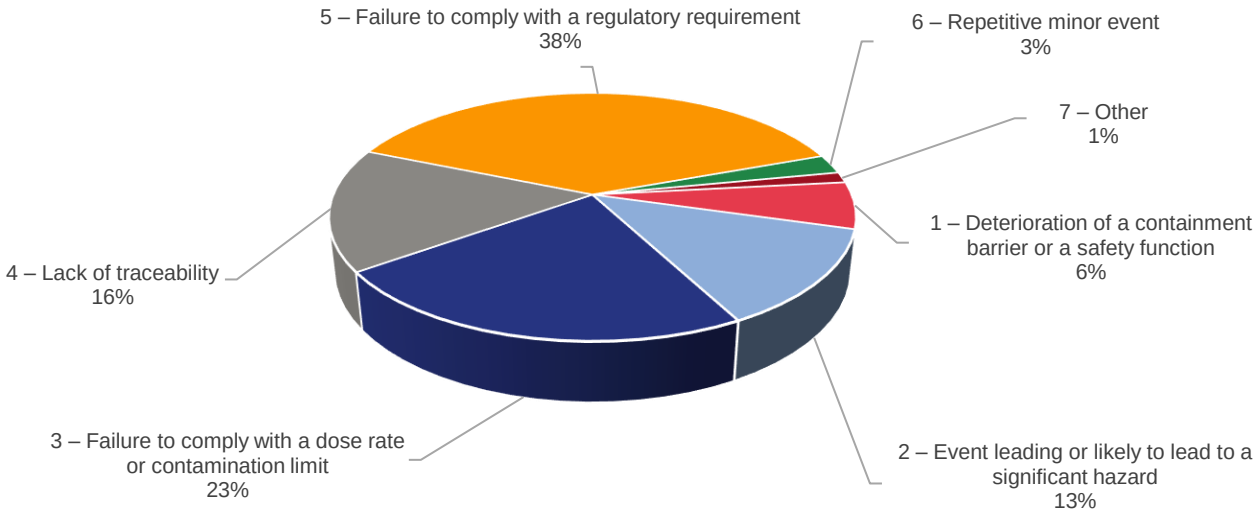

Figure 10 – Breakdown of STE by notification criterion over the 2021-2024 period.

1.6.2. Phase in which the event was detected

By law, transport includes all the operations and conditions associated with the transfer of radioactive materials and packages – from the design of the packaging to the receipt of the package at its final destination. Therefore, it also includes the manufacture, maintenance and repair of the package, as well as its preparation, dispatch, loading, forwarding, in-transit storage and unloading.

As a result, any of these steps could potentially lead to a significant event being reported to the ASNR. This is confirmed in figure 11 for the 2021-2024 period. It should be noted, however, that the receipt phase (at consignee) is the phase during which events are most often detected. This confirms the importance of carrying out checks upon delivery.

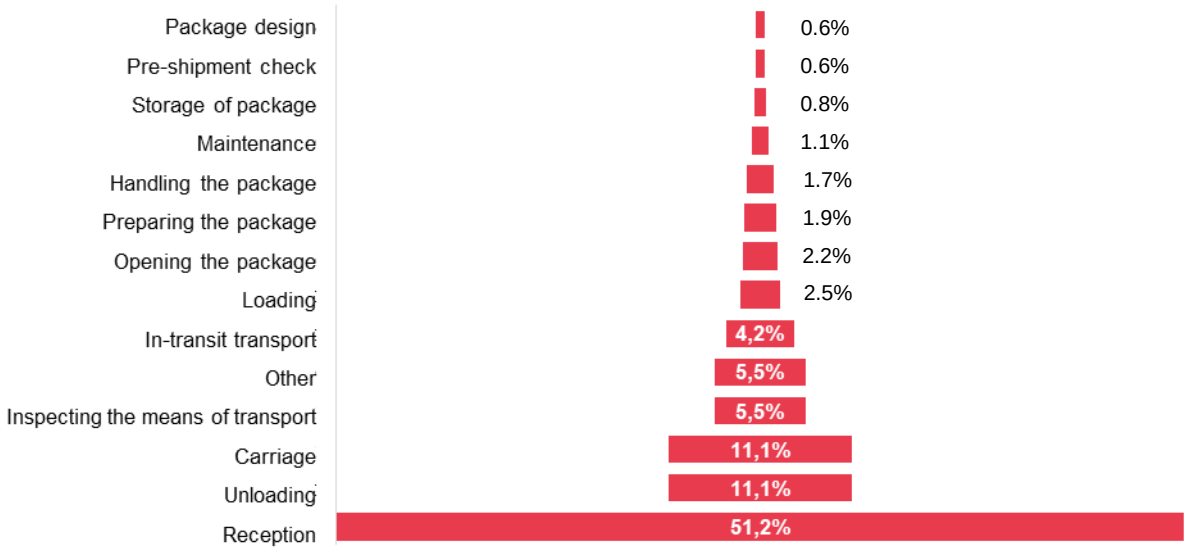

Figure 11 – Breakdown of STE reported over the 2021-2024 period according to the phase in which they were detected.

The events detected when handling a package correspond, with a few exceptions, to those detected when changing the mode of transport. Intermediate checks are carried out to ensure that the package remains compliant throughout its entire journey. For example, moving a container could lead to a change in the dose rate measurement if the contaminated materials and tools that it contains move around inside the packaging when the mode of transport is changed. This is, in fact, the main cause of events detected during the transport of packages or containers.

As far as inspecting the transport units is concerned, this refers to the checks carried out after the package has been unloaded.

Lastly, the “Other” line includes, in particular, the discovery of a discrepancy when:

- processing waste;
- dismantling or unloading a tank;
- receiving a non-class 7 (exempted) transport units;
- patrolling a storage site;
- preparing an application to renew transport approval;
- carrying out a post-clearance check of the transport documents by the consignor.

1.7. Deadlines for reporting an event on-line and for submitting a Significant Event Report on-line

Over the 2021-2024 period, just about 62% of the events were reported on-line within the regulatory deadline (figure 12). As a reminder, in accordance with Article 7 of the TMD Order, a significant event must be reported via the ASNR’s on-line events notification service within **four working days of the event being detected**.

A mere 37% of Significant Event Reports were submitted electronically within the regulatory deadline, which is **two months from the time the event was reported**[16]. Focusing solely on 2024, this proportion increased to 52%, but there is still room for improvement.

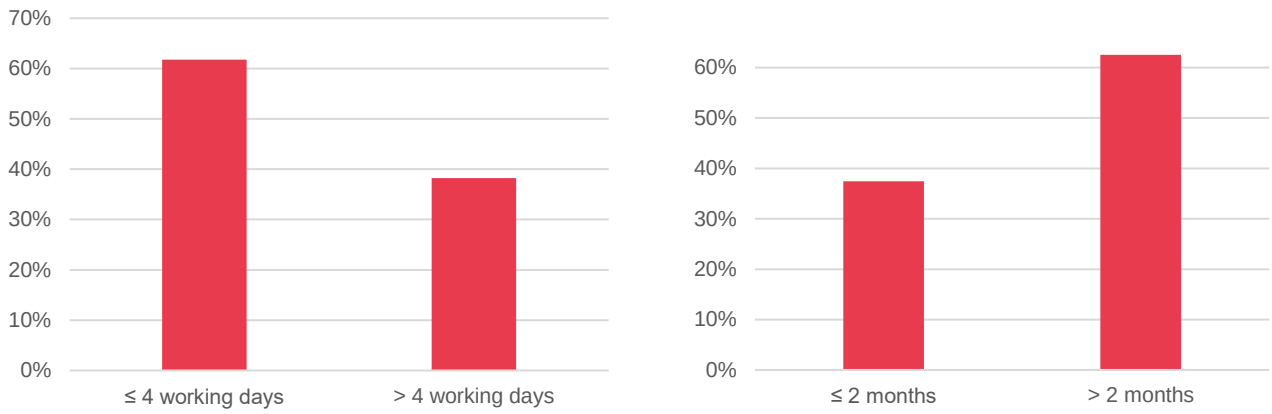

Figure 12 – Time taken for STE to be reported online (left) and for Significant Event Reports to be submitted online (right) over the 2021-2024 period.

Under these circumstances, the ASNR regularly contacts the people responsible for events in order to obtain the Significant Event Report, study the analysis, chart the events that occurred, and assess the actions taken in the short and medium term.

Failure to comply with the provisions of the TMD Order, the ADR, the RID and the ADN relating to "documents that must be submitted or made available to the competent authorities" is liable for punishment by a fifth-class fine (Article R. 1252-9 of the French Transport Code).

In addition, Article L. 596-11 of the French Environment Code also provides for fines or imprisonment in the event of failure to report.

The ASNR draws attention to the importance of carrying out an analysis of the events so that the safe transport of radioactive substances can be promoted by learning from mistakes, and sharing the lessons learned and good practices identified.

[16] Since 8 July 2024 – Order of 29 May 2009, amended, concerning the transport of dangerous goods by land (referred to as the "TMD Order")

Find out more

- ASNR Guide 27: *Stowage of radioactive packages, materials or objects for transportation*
- ASNR Guide 29: *Radiation protection in radioactive substance transport activities*
- ASNR Guide 31: *Procedures for reporting events concerning the transport of radioactive materials on the terrestrial public highway, by sea or by air*
- ASNR Guide 44: *Quality management system applicable to the transport of radioactive substances on public roads*
- ASNR website on the transport of radioactive substances
- Chapter 9 dedicated to transport in the various ASN annual reports
- Guide ED 6134 of the French National Institute for Research and Security (INRS): *Le transport des matières dangeureuses : L'ADR in question ("The transport of dangerous goods – the ADR in question")*
- INRS Guide ED 766: *Chariots automoteurs de manutention – Manuel de conduite* (Self-propelled industrial trucks – *Driver's manual)*
- Guide of the French Civil Aviation Authority (DGAC): *L'ABC des MD ou petite introduction aux marchandises dangereuses ("The ABC of dangerous goods or a short introduction to dangerous goods")*
- Guide of the French National Federation of Decontamination and Environment Activities (FNADE) and the French Federation of Industrial Maintenance, Sewer System Maintenance, and Environmental Management (MAIAGE): *Guide of good ADR practices for the waste processing industry*

Section break

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