Transport of Radioactive Materials

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Abstract

Daily, transport of radioactive materials takes place from NRG facilities to clients or to other Petten site facilities. For instance, in 2001 a total of 739 containers were transported to external clients, not including internal transports.
In the Netherlands requirements are applicable to the transport of radioactive materials. These are laid down in a number of decrees, including attachments [1,2]. One of the attachments concerns the transportation by rail or over land of dangerous goods. Since 1985 these attachments are in agreement with the ADR (**A**ccord Européen Relatif au Transport International des Marchandises **D**angereuses par **R**oute) [3]. At this moment 33 European countries accepted the ADR rules.
Next, regulations with respect to transport by air are set by ICAO (**I**nternational **C**ivil **A**viation **O**rganisation).

Transport of radioactive materials is closely related to safety. The safety aspects are a main concern within NRG. To identify safety issues internal auditing as part of the Management System is an excellent tool to get a first impression of these issues. However, active participation of the management is required. Recently, an update of the NRG Management System has been carried out and two new procedures with respect to transport of radioactive materials will be implemented.

In this report a summary is given of the requirements for transport of radioactive materials from and to NRG. Since a lot of aspects are involved not all related subjects will be discussed. The Dutch situation with respect to safety requirements and training requirements of persons involved, as well as the types of containerisation, allowable radiation and contamination levels will be highlighted. In this paper no specific values are mentioned with respect to activity and contamination level, or to labelling and identification standards. They are all referred to the ADR rules. Finally, some types of containers for internal use and internal transport are discussed briefly.

1. Introduction

1.1 General

The transport of dangerous goods takes place all over the world. In the end all transport branches dealing with this kind of transport are involved. All problems encountered have to be solved worldwide. The United Nations Committee of Experts on the Transport of Dangerous Goods is the leading authority in this field. This authority is assigned to co-ordinate all economic and social activities of international organisations. They also act as a contact for other specialised agencies and other international and non-governmental organisations dealing with the transport of dangerous goods, like manufacturers, transporters, and truck builders. In Europe road transport is co-ordinated by the Economic Commission of Europe (ECE).

The problems that can arise with regard to transport of dangerous goods can be very extensive. First of all it concerns the substance itself for which a solution must be found. A small amount of dangerous good can cause danger to the public and environment. One has to consider proper packaging, stowage, the way of transport itself, necessary paperwork and procedures covering the transport. Last but not least one has to consider the various international regulations and organisations, which can influence the transport, like environmental organisations, organisations dealing with working conditions or trading associations. In short, transport of dangerous goods is a multidisciplinary activity, which is covered by national and international rules and regulations.

More and more these rules and regulations are being harmonised. In 1993 the “Working Party on the Transport of Dangerous Goods” started to re-structure the complex ADR rules. User’s friendliness and more consistency were a main objective. Other international working parties and committees were involved, resulting in the revised version of the ADR rules by July 2001. Other branches revised their rules as well and a transitional arrangement was agreed. The old ADR rules are still valid until January 2003 (with the exception of Class 7 “Radioactive Material”, which is valid till January 2002) and by this time all other revisions have to be implemented.

1.2 ADR

The ADR dated from 1957 and became internationally effective in 1968.
Transport of dangerous goods can happen by road, rail, air, seas, or inland waterway. Each branch has its own specific requirements yielding to specific rules and regulations. In Europe this is co-ordinated by the Economic Commission of Europe (ECE). Part of this commission is the Inland Transport Committee, where the "Working Party on the Transport of Dangerous Goods" is responsible for the ADR.

1.3 European Union guidelines

In the field of transport of dangerous goods the European Commission plays an important role in assigning guidelines to realise one safety level for the transport of dangerous goods between European Union countries. One of these guidelines is 94/55/EU, known as the ADR guideline. A number of clauses are part of the Netherlands' regulations.

1.4 ADR guideline

This guideline has been recently revised in July 2001. On the basis of this guideline all member states are obliged to declare the ADR rules valid for transport between member states and national transport. This leads to the following three consequences:

- The ADR is valid for all international transport of dangerous goods within the European Union.
- The ADR is valid for all national transport. For the Netherlands this also has no effect since the complete ADR rules are effective for the national transport.
- The most important effect of the ADR rule is to maintain some national agreements for transport.

In the following chapters the Netherlands' situation with respect to safety and training requirements of persons involved, as well as the types of containerisation, allowable radiation and contamination levels will be highlighted. Finally, some types of containers for internal use and internal transport are discussed in short.

2. Safety requirements

2.1 General safety care

Organisations and their personnel involved in the transport of dangerous goods have to take measures according to the nature and magnitude of the foreseeable dangers to prevent damages, and if damages occur to limit the magnitude. In any case they shall comply with the ADR rules.

The organisations involved should immediately report a possible danger for the public safety to the respective authorities and provide them with the necessary information.

2.2 Duties

a. Sender

Offered dangerous goods shall meet the requirements in conformance to ADR rules.
Particularly, the sender:

- Makes sure that the goods are classified according to ADR rules and that transportation is allowed;
- Supplies the carrier with all necessary and required information as well as all the transport documents, including permissions, certificates;
- Only uses packages which are allowed and appropriate for transport of the goods involved and completed with the prescribed identifications;
- Complies with the regulations for transportation and limitations for transport.

The sender has to take measures to guarantee that the carrier meets the ADR requirements, if the sender does not transport the goods himself.
If sender acts under third party orders, then he shall inform the sender about the nature of the goods and provide him all necessary information and documentation to comply with the regulations.

b. Carrier

The primary responsibilities of the carrier are:

- Check if the offered goods are allowed to be transported;
- Make sure that the prescribed documents are included;
- Check by visual inspection that the truck and freight show no defects, no leakage or cracks and no relevant equipment is missing;
- Make sure that certification of equipment is still valid;
- Check that the truck is not overloaded;
- Make sure that all necessary identifications are fitted;
- Make sure that all personal protective equipment as mentioned in the driver's instruction, is present and ready for use. In some cases this is part of the transportation documents.

If the carrier notices that violation of the rules has taken place transportation shall be stopped until the requirements are met.

If during a transport a violation is observed, which possibly can lead to a reduction of safety, then the transport shall be detained with regard of the traffic regulations and public safety. The authorities responsible for the remaining route can approve continuation.

c. Receiver

At delivery of the goods the receiver has to verify and unload the freight as soon as possible as well as to check if all is in accordance with the ADR rules.
Next, the receiver has:

- If necessary, according to ADR rules, to clean and decontaminate the container and the truck;
- To take care that the unloaded, decontaminated and degassed container is free from any danger indications.

If the receiver makes use of other services (unloader, cleaner, or Decontamination Company) the receiver has to take appropriate measures to guarantee that the ADR rules are observed.
If during these checks a violation of the ADR rules is noticed, the receiver may not release the container until it complies with the rules.

3. Types of packages

Containers can be distinguished between containers for transport of radioactive materials and transport of fuel. With radioactive materials there is a risk for radiation of persons during transport and handling as well as a risk when the containment is damaged.
A possible risk during transportation of fuel is the chance of a chain reaction if the fuel comes into contact with sufficient water.

The requirements for containers are very stringent and dependent of the dangers connected to transport conditions. The following distinctions can be made:

- Normal transport conditions (without any incidents);
- Transport conditions with expected minor incidents;
- Conditions whereby accidents can occur during transport.

The types of containers for radioactive materials with increasing degree of allowable activities are:

- Exempted package

  This is a container in which instruments, objects or substances with a limited amount of activity. The specifications are in conformance to ADR rules.
- Industrial package

This package is for objects with a Low Specific Activity (LSA) or Surface Contaminated Objects (SCO), which meets the ADR requirements. Three sub divisions can be distinguished, type 1, 2, and 3 (or IP-1, IP-2, and IP-3), each with increasing design and performance requirements.

- Container type A

  This container can contain material of which the activity level is between A_1 and A_2, depending on the specific condition of the material. *A_1 and A_2 are defined as the boundary value of activity level (TBq) of radioactive material in a special condition or with the exception of material in a special condition* *respectively, as incorporated in the ADR rules, and is used to determine the boundary values of the activity.* In table 1 a number of A_1 and A_2 values are given for some elements.

- Container type B

  This container can contain material of which the activity level can be higher than A_1 or A_2.
  A certificate limits the nature and amount of activity.
- Container type C

  This type of container is specially designed to transport highly active material (>(3×10^3) A_1 to (1×10^5) A_2 by air.

table 1 A_1 and A_2 boundary values for some elements

Radio nuclide (Atomic number)	A_1 value (TBq)	A_2 value (TBq)
Al-26	1×10^{-1}	1×10^{-1}
Be-10	4×10^{1}	6×10^{-1}
C-14	4×10^{1}	3×10^{0}
Co-60	4×10^{-1}	4×10^{-1}
Cr-51	3×10^{1}	3×10^{1}
Cs-134	7×10^{-1}	7×10^{-1}
Fe-59	9×10^{-1}	9×10^{-1}
I-131	3×10^{0}	7×10^{-1}
Ir-192	1×10^{0}	6×10^{-1}
Mn-54	1×10^{0}	1×10^{0}
Ni-63	4×10^{1}	3×10^{1}

4. Training requirements

For Class 7 ("Radioactive Materials") personnel shall have appropriate training with regard to radiation dangers as well as to take precautionary measures to limit their exposure and others.
In table 2 the training requirements for drivers transporting Class 7 material is given.

table 2 Training requirements for drivers

<table>
<tr><td colspan="2">Exempted packages</td><td></td><td></td></tr>
<tr><td colspan="2">LSA / SCO</td><td>General ADR certificate [1]</td><td>Specialised training Class 7 [2]</td></tr>
<tr><td rowspan="2">Type A</td><td>No Fission Material < 10 containers and sum transport index (TI)<3 [4]</td><td>Appropriate training and instruction [3]</td><td rowspan="3"></td></tr>
<tr><td>No Fission Material >10 containers or sum TI>3</td><td>General ADR certificate [1]</td></tr>
<tr><td colspan="2">Type B</td><td>General ADR certificate [1]</td></tr>
</table>

[1], [2] Mandatory revision course every 5 years
[3] Employer shall demonstrate a certificate
[4] TI = Transportation Index; see paragraph 5.2

5. Allowable radiation and contamination levels

5.1 Dose rate

In table 3 the ADR requirements with respect to the maximum allowable dose rate (mSv/h) are given.

table 3 Allowable dose rate (mSv/h) according to ADR

			Surface mSv/h	1 meter mSv/h	2 meter mSv/h
Exempted packages		Package	0.005	-	-
Other packages	Normal use	Package	2	0.1	-
		Truck	2	-	0.1
	Exclusive use [1]	Package	10	-	-
		Truck	2	-	0.1

[1] Exclusive use means *that the receiving side is notified of the transport in advance and measures are taken to accommodate the package immediately upon arrival.*

5.2 Transport index

The transport index (TI) for a package, container, or unpacked LSA or SCO goods, is the figure which is derived according to the ADR rules using the following method:

a. Determine the highest radiation level in mSv/h at a distance of 1 meter from the outer surfaces of the package, the container or unpacked LSA or SCO goods. The measured value is multiplied by 100, resulting in the transport index.
b. The value obtained from a) has to be rounded up to one decimal point, except if the value is lower than or equal to 0.05.

The transport index for packages, containers, or trucks is determined by adding the TI's of all present packages or to measure the radiation level directly.

5.3 Contamination level

In conformance with the ADR rules the non-fixed contamination at the outer surfaces of each package has to be as low as possible and may not exceed under normal transport conditions the following values:

a) 0.4 Bq/cm^2 for all other alpha emitters,
b) 4 Bq/cm^2 for beta and gamma emitters, and alpha emitters of limited toxicity;

6. Internal transports at Petten site

6.1 Regulations

At the Petten site 4 companies are situated, ECN, JRC, NRG, and TYCO. In general, if a transport container has been certified following ADR requirements, the ADR directives are applicable and must be followed. This pertains to all classes of containers and or packaging.
The ADR prescribes tests on packaging that must be passed successfully. These tests are designed such that specific classes of accidents do not lead to unacceptable high radiation fields or leakage of radioactive material. The tests and class of accidents depend on the kind and quantity of radioactive materials. It is obvious that on the Petten site certain accidents are impossible like a collision with a train or falling from a bridge. Since the distance to be traversed and the speed of transport is limited the probability of accidents is reduced considerably.

The ADR rules are **<u>not</u>** applicable to internal transports over the company's area and to and from JRC or TYCO. Yet, the rules are applied as much as possible. However, a number of agreements are adjusted with respect to the use of not-ADR-certified containers (such as Graviner, Tonolli, WI, and WII), contamination standards, labelling of packages and transport documents.

Therefore, conditions and agreements between all the parties involved are laid down in a document "Transport Regulations for the Petten site" [4,5]. Requirements for the use of a transport container within the Petten site are as follows:

- The container must be on the list of admitted containers (table 4);
- The container may only be used for the purpose mentioned on this list;
- The responsibility for the correct procedure lies with the senders side;
- The ADR rules are applicable for the certified containers, with the exception of labelling and transport documents;
- The sender is responsible for the procedure;
- The dose rate (referes to effective dose as defined in ICRP-60) at the surface is lower than 2mSv/h. For "exclusive" transport this limit may be raised to 10 mSv/h;
- The dose rate at 1 m is lower than 0.1 mSv/h (for exclusive use 1 mSv/h);
- The dose rate for the driver shall be less than 0.02 mSv/h;
- Representative wipe tests (over 300 cm^2) at the outer side of the package may not be higher than 0,4 Bq/cm^2 for α emitters and 4 Bq/cm^2 for α and γ emitters;
- The transport is accompanied by the following documents:
  - General Transport Document;
  - Request for Radioactive Waste Disposal or Treatment;
  - Request for Decontamination.

Any of the above mentioned regulations may be overruled by a specific exemption granted in writing by the Radiation Protection Officer of the sender and receiver on special request. The list of containers satisfying the Transport Regulations for the Petten site is shown in table 4.

table 4 List of transport containers satisfying the Transport Regulations for the Petten site

Name	Number	Useful space (mm)		Lead thickness (mm)	Weight (kg)	Purpose	Owner(s)
		length	diam.				
Tonolli	1	2150	160	275	14235	Experiments / capsules	NRG
Graviner	1	1037	124	150	2789	Experiments / capsules	NRG
Graviner	1	585	124	150	2040	Experiments / capsules	NRG
Waste container	4	856	292	200	5675	Waste transport	1 and 4 NRG / 2 and 3 JRC
Container	3	155	75	50	85	Multi purpose	NRG
STEK container	1	447	160	180	2220	Steel transports	NRG
Container	2	298	298	100	1424	Multi purpose	NRG
Container	2	298	196	150	1574	Multi purpose	NRG
Container	2	298	98	200	1642	Multi purpose	NRG
Container	1	860	630	90	4500	Multi purpose	NRG
Ilonka	1	2450	235	250	15000	Longer syntacs	JRC
Goslar container	1	856	235	300	12410	U-residue (Mo prod.)	TYCO
P-container	6	700	235	220	4800	Storage	NRG
Lemair	2	160	100	150	605	Multi purpose	NRG
Lemair	2	150	75	110	280	Multi purpose	NRG
Lemair	3	75	32	50	32	Multi purpose	NRG
Lemair	2	130	30	100	150	Multi purpose	NRG
Lemair	1	100	30	75	80	Multi purpose	NRG
Lemair	1	155	75	100	250	Multi purpose	NRG
Lemair	1	330	100	90	300	Multi purpose	NRG
KfK	1				4340	Waste (Mo prod. / research lab HCL)	TYCO
Petten	1				±350	General bulk quantities	NRG
Sample Container	1				<20	Samples ^{99}Mo	TYCO
Rb / Kr	1				±150	Rb / Kr bulk	TYCO

6.2 Containers used at the Petten site

As can be seen from table 4, NRG, and more specific the Hot Cell Laboratories (HCL), can handle 24 types of containers. The dimensions of the containers vary from 75 mm to more than 2 meters in length and from 30 to nearly 300 mm in inner diameter. This also accounts for the weight of which the heaviest is 15 tons (Ilonka container). The enlisted containers are used for internal transports only. Some of these containers are used for special purposes, like the ones used by TYCO. Most of the containers are multi purpose. The choice of a container depends on the material to be transported. This can vary for example from solids to fluids or gaseous to non-gaseous materials. The maximum load and related contamination is equivalent to a dose rate at the surface of 2 mSv/h or less than 0.1 mSv/h at 1 m. This dose rate is based on a ^{60}Co source. However, for exclusive transports the dose rate might be higher but must never exceed 10 mSv/h and 1 mSv/h at 1 meter respectively. In these cases the receiver has to be notified of the deviating transport and has to accept it. In figures 1 to 5 some of the Petten site containers are shown. Some specific characteristics of these containers are given hereafter.

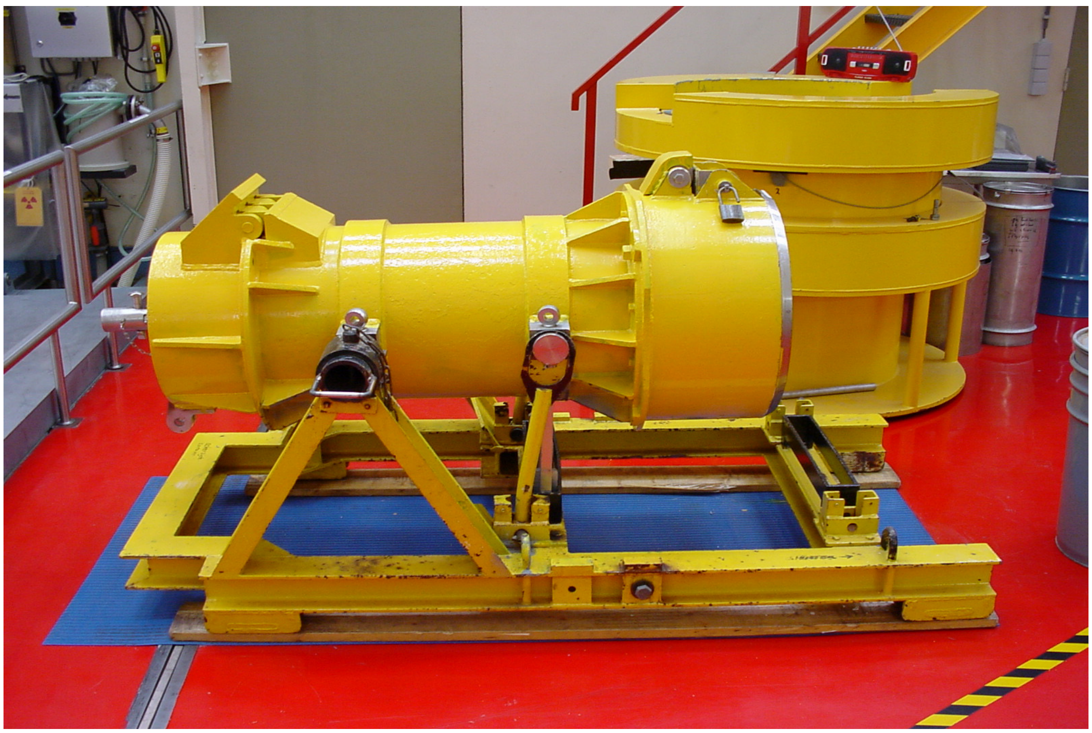

figure 1 Graviner container

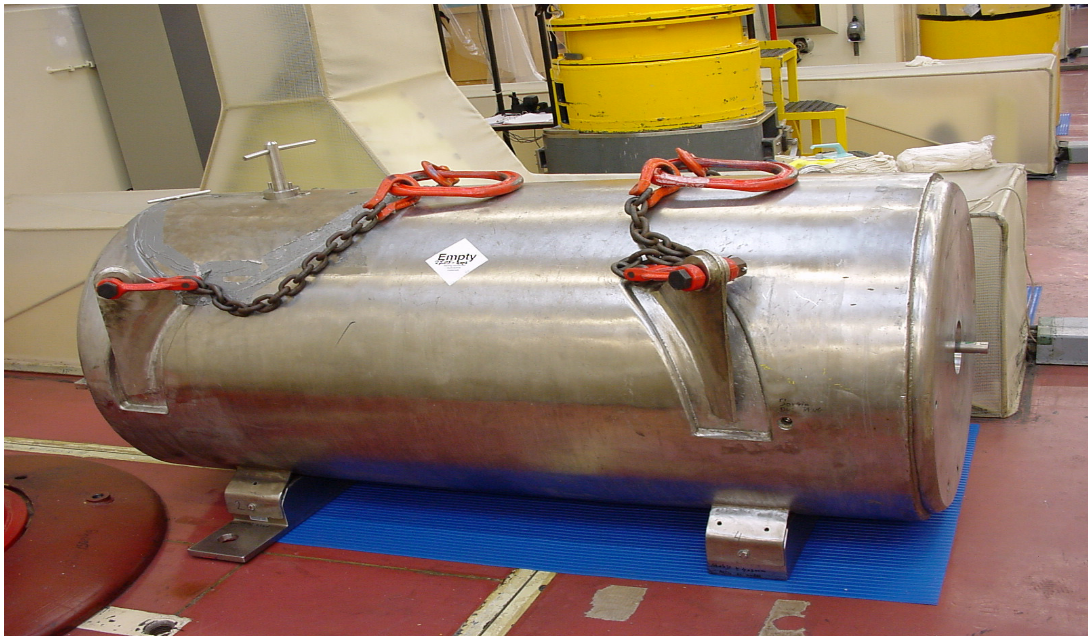

figure 2 Goslar container used for transport of U-residue from the Molybdenum production facility

The Graviner container

This container always needs a hoisting mechanism, because it has no own support. The middle part of the container can be extended. It is suitable for loading and unloading under water and the water drainage is done automatically by a labyrinth construction. Inside the container a shovel is available if loading is done outside the water, like the loading of isotope cans. It is provided with a vertically sliding shutter. Transports from and to the HFR are mostly done with this container.

The Goslar container

A “gastight” (Syntax 210) can, including a clamping device is a typical load for this container. During unloading in the cell the underpressure is maintained. Loading and unloading can only be done in a horizontal position. A ball valve is used as a shutter.

figure 3 Tonolli container to transport irradiation capsules from HFR to HCL

figure 4 JRC solid waste container

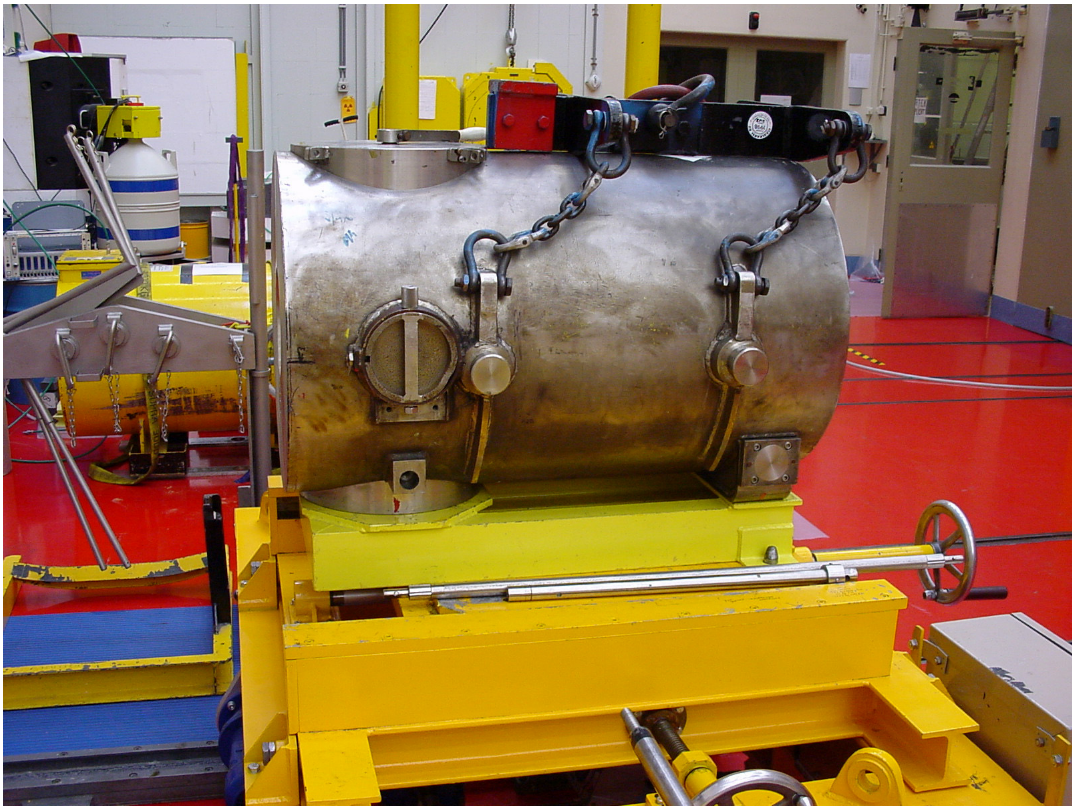

figure 5 STEK container for internal laboratory transports of steel samples from highly active to medium active hot cells

The Tonolli container

This container is suitable for loading and unloading under water. Loading and unloading can be done at a certain angle. It has a hoisting mechanism, which can be lowered down. A drain plug is used to drain the container. The shutter is of the cylindrical type with a horizontal hole.

The JRC solid waste container

This container is only suitable for vertical loading or unloading and it is equipped with a manual hoisting mechanism. Besides the hoisting mechanism, also a grabber and a vacuum nap are available. It is mostly used to transport vessels. The horizontal shutter consists of two sliding halves, which are moved and locked manually.

The STEK container

Interlaboratory transports of steel samples from the high active to the medium active hot cells are done with this container. It has its own hoisting mechanism, so that loading and unloading can be performed either horizontally or vertically. Inside the container a lockable can is available. The shutter is of the cylindrical type.

7. Conclusions

The transport of dangerous goods is a multidisciplinary activity, which is covered by international rules and regulations. Although these rules and regulations were harmonised recently the ADR is still complex, since a great number of parties are involved.

The old ADR rules are still valid until January 2003 (with the exception of Class 7 "Radioactive Material", which is valid till January 2002) and by this time all other revisions have to be implemented.

Transport of radioactive materials is a daily activity at the Petten site ever since the institute is dealing with nuclear research. These transports are closely related to safety, which is a main concern of the NRG Management. The active participation of the management resulted in the implementation of procedures regarding this subject as part of the Integrated Management System.

Experiences at NRG have learned that the ADR has been well implemented. Part of the implementation is to organise and provide training to all personnel involved.

In 2000 a total of 691 containers were transported, which increased to 739 containers in 2001. During the transports in 2000 only 5 ADR non-conformances were registered from **external** transports. Two of them had an administrative nature, such as a missing copy of the transport license, or not having a Dutch identification label. The others concern improper dose values on the documents or wrong storage of the goods. An overview for 2001 is not available yet.

In the last 5 years non-conformances with regard to **internal** transports of radioactive materials were not registered.

8. References

[1] Regulations for the Safe Transport of Radioactive Material, 1996 Edition (revised) IAEA Safety Standards Series No. TS-R-1 (ST-1, Revised) Vienna, 2000.
[2] Nederlandse Vereniging voor Stralingshygiëne (NVS) "Aanvulling bij NVS-Publicatie nr. 26 "Het Vervoer van Radioactieve Stoffen over de Weg in Nederland" (in Dutch).
[3] Accord Europeen Relatif au Transport des Marchandises Dangereuses par Route (ADR).
[4] A.S. Keverling Buisman "Transport Regulations for the Petten site", NRG Report 99.30576, 3 January 2000.
[5] J.M. Lutgerink "Transporten met Radioactief Materiaal", NRG Report 02.47513/I, 1 September 2002.

Transport Procedures at ITU: Licensing and Technical Aspects

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Abstract

The transport of nuclear materials is regulated by national and international norms that have to be followed in an exact manner to assure the safety of the transport and to comply with the pertinent regulations. At the Institute for Transuranium Elements, from the licensing point of view, several regulations have to be considered, namely, The Atomic Act Licensing, the Dual-Use System and the Transport and Container-Licensing. The essential steps are briefly described. Concerning the technical aspects the handling of containers and the loading and unloading procedures in the hot cell installation and the transfer system from the entrance hot cell (β/χ-zone) to the α-zone based on a double-lid system are discussed.

1. Licensing aspects

1.1 Containers validation and transport licensing

Transport of fissile materials has to be executed according to the Atomic Act and to ADR-regulations. The container for the transport has to be validated and certified:

- In the country of origin of the container
- In the country of departure of the transport
- In each country the transport has to pass by, and
- In the country of arrival of the transport

In Germany the nuclear cargo enterprise in charge of the transport has to formulate a demand by the Bundesamt für Strahlenschutz (BfS), providing all the technical and radiological relevant information and safety documentation together with the original certification of the container. With this information, the BfS demands the technical advice of Bundesamt für Materialforschung (BAM), which usually makes recommendations. On the basis of the BAM-recommendations, the BfS issues the validation of the transport container and grants the transport licensing according to the ADR-regulations and transport licensing consistent with the § 4 of the Atomic Act.
This procedure has to be followed in each land through which the transport has to pass through, in accordance with the local regulations.

1.2 Export and import licenses

1.2.1.Atomic Act (AtG) (export and import)

For each importation or exportation of more than 15 g of fissile material, one license according to the §3 AtG (Atomgesetz, Germany) is necessary. The demand of this license is made by ITU to the BAFA (Bundesamt für Wirtschaft und Ausfuhrkontrolle). The demand must contain:

- The description of the material to be transported
- The quantity of the fissile material and its isotopic composition,
- The material delivery note

1.2.2 Dual-Use System licensing (exportation)

For the exportation of radioactive material, the Dual Use System Licence is necessary:

- Outside of the European Union: for each quantity of Uranium and / or Plutonium to be transported.
- Inside of the EU: by separated Plutonium or enriched Uranium with more than 20 % enrichment.

1.2.3 Customs regulation (outside of the EU)

Before any transfer orf radioactive material outside the country, if a license of exportation is necessary, a declaration of exportation is to be made by the customs- office. If there is no license is needed, a registration of the exportation by the customs-office is enough.

In conclusion it can be said that the organisation of a transport of radioactive material is a long and cumbersome procedure. It is important to have the whole and correct information just before the beginning of the procedure of the transport licensing. According to our experience, it is usually difficult to prospect predict a precise date for a transport because of the reliance on licensing authorities and on the momentarily political situation.

2. Technical aspects of the transport of irradiated fuel rods at ITU

The technical aspects of the transport of irradiated fuel rods (FR) at the Institute for Transuranium Elements are mainly related to the technical features of the installation (**see Fig. 1**). The installation is divided in two main groups of hot cells: on one side the α-hot cells comprising, besides the β/χ-shielding, an α-tight box whereas the entrance hot cell, HC-101, is a β/χ-zone where no α-open source is admitted.

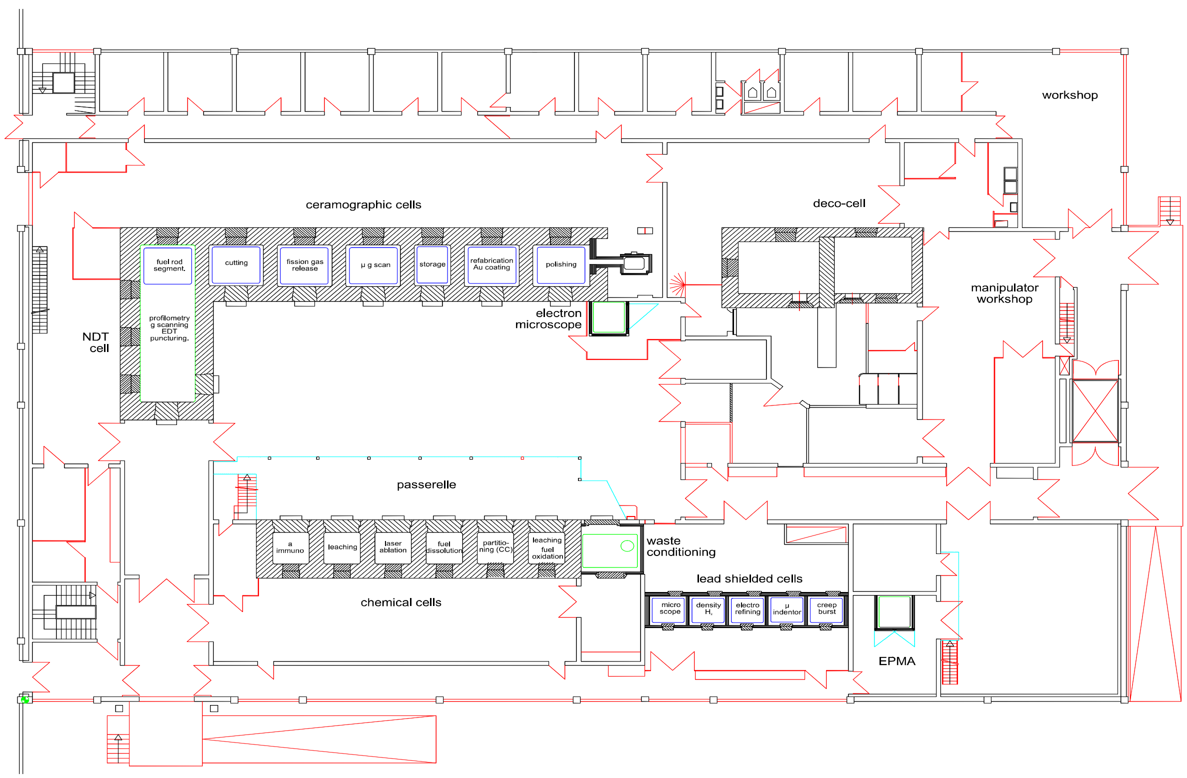

FIGURE 1: Institute for Transuranium Elements, hot cell installation

The transport itself is performed, using licensed containers as described above, transported in vans up to the ramp in front of the installation. There a heavy crane (up to 40 tons) can unload the container to a heavy-duty conveyor, which, over rails, can transfer the container to the entrance hot cell. There the container is coupled to the loading port (**see Fig. 2**), which remain closed until the α-tight connection has been performed. After that the loading port may be opened and the ?quiver? containing the fuel rods can be slid into the hot cell and, then, the fuel rods can be discharged into the hot cell.

The entrance hot cell is, at the same time, dedicated to two important functions: to perform the non-destructive analysis (NDA) and the storage of the irradiated fuel rods until the NDAs analyseis haves have been completed.

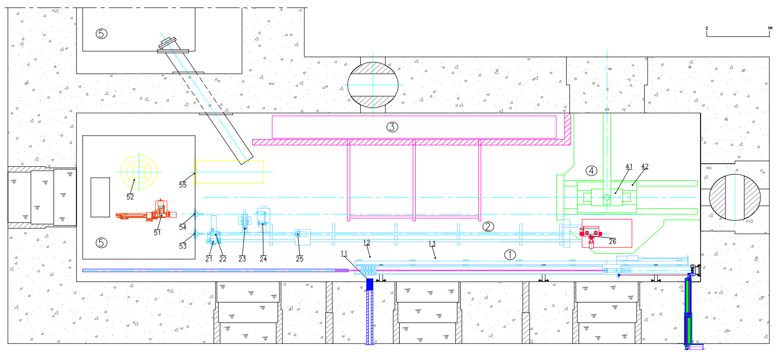

FIGURE 2: Entrance hot cell

The entrance hot cell is, at the same time, dedicated to two important functions: to perform the non-destructive analysis (NDA) and the storage of the irradiated fuel rods until the NDAs have been completed.

After having performed the NDA, the FR hadve to be transferred to the α-zone for the cutting of samples to perform the destructive analysis. Several possibilities are foreseen in the installation for transfers between the two zones and internally in the α-zone:

i) a transversal connection for fuel bundles up to 100 mm in diameter

ii) a magnetic conveyor along the two lines of α-tight boxes

iii) a pneumatic system between the metallurgical hot cells and the chemical and small hot cells, and

iv) two La Calehne doble-lid connections between the hot cell 101, β/χ-zone and the α-tight box

The La Calehne connections are for the fuel rods the way into the α-zone, after segmentation and cutting of the needed samples, as well as the way out of it of the fuel rod remnants. In fact, after having performed the destructive analysis, the fuel rods have to be re-encapsulated for the back transport to the reactor pool. After having performed the destructive analyses, the FR-remnants are introduced into a capsule, having a diameter slightly bigger than the original FR and, after He-filling, these capsules are welded shut for the back transfer to the reactor pool.

Radioactive Transports

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Abstract

The transport of radioactive materials has a long experience at PSI, both at national and international basis. The range of radioactive materials transport includes waste, radioisotopes, components, fuel elements/pins and samples of MOX. A Quality Assurance System is used and Safeguards controls are applied. PSI has also transport packages of type A and Type B (U) for small quantities of fuel.

1. Introduction

The transport of radioactive materials at PSI started almost 40 years ago with national and international R&D activities and transport of nuclear fuel for the former research reactors SAPHIR, DIORIT and the PROTEUS reactor still under operation. Spent fuel was sent in the 60's to France and Belgium for reprocessing (reactor DIORIT) and fuel was brought from USA for the reactor SAPHIR. At the zero power reactor PROTEUS fuel ranging from fast breeder, HTGR, MOX and advanced LWR (PWR & BWR) has been studied and measured.

Meanwhile, spent fuel from SAPHIR has been returned to USA and spent fuel from the last DIORIT core has been stored in a dry transport Castor cask (since about 20 years).

2. Transport modes and experience

All mentioned activities have demanded very intensive transport work in Europe and in the USA and accomplished without problems. Different casks have been used for MTR fuel (fresh and irradiated), large casks for MOX and special ones for HTGR fuel and transport modes ranging from road, sea and air carriers have been achieved without problems.

On the other hand an intensive R&D programme and supply service of radioisotopes for medicine, industry and research has been carried out at PSI in the last 20 years and covering transport activities in Europe, USA and other countries.

Additionally, PSI is responsible for the collection, conditioning and interim storage of all radioactive materials produced in medicine, research and industry facilities in Switzerland; yearly transports of these materials to PSI are required.

3. Transport of R&D fuel

Parallel to the mentioned activities, the PSI Hot laboratory started operations in the sixties and dealing with fuel examination (PIE), isotope production, reactor material and components examination and nuclear waste disposal research.
Meanwhile a plutonium fuel R&D programme achieved international status in Europe, Japan, France etc. and MOX fuel has been transported nationally and abroad.

Developments on higher burnup of LWR fuel continue to be examined at PSI, including mechanical testing of irradiated cladding materials; the international collaboration with other research facilities abroad demands the transport of theses materials from the Swiss nuclear power plants to PSI and also to the foreign facilities.

Recent developments dealing with the Generation IV Systems (R&D efforts on advanced nuclear power concepts) show the necessity of advanced fuels e.g. TRISO UOC (VHTR), UO_2 (SCNR-Th) etc; these fuels aim to high temperatures and therefore to higher burnup and of course to the transport of specimens/fuel elements in adequate casks. A new situation which must be addresses properly and as required.

4. The trasport technology

The transport of radioactive materials is not trivial; this activity is included in the group dealing with dangerous goods and regulated in all modes of transport: road, rail, air, sea and waterways. All regulations are based on the IAEA Safety Standards and in the specific transport modes and additional national legal framework.

In order to comply with the regulations and the legal framework, it is demanded by the nuclear regulatory authorities to use among others, a Quality Assurance System in accordance with the IAEA regulations and implemented as needed with ISO-standards and own procedures.

A Quality Assurance System which complies with the mentioned regulations was developed at PSI and applied since 1994; most of all requirements and corresponding controlling activities existed, nevertheless the building-up effort to tight the different quality elements in the transport process was done.

The transport process follows the specific radioactive material e.g. three main types of them and five lower categories under the general radioactive materials (none fuel). In order to apply the QA-System to a given material, specific Quality Assurance Plans (QP) are used. The QP covers basically the following main steps of the transport process:

- Transport Planning and Organisation
- Transport Arrival (with empty or loaded package)
- Transport Departure
- Package Arrival verification (empty or /loaded)
- None Conformity control and procedures
- Documentation

All these process steps follow the QA-System elements, their requirements, responsibilities and verification documents.
The operational success of the QA-System requires not only the system documents from the user and elsewhere (transport company, cask supplier, regulatory authority etc.) but a continuous control of the technical status of the transport systems, the personnel qualification and effective management. The coordination and team work with qualified transport organisations is required in order to sustain the achieved high nuclear safety records.

We have a safeguard control system and also a security control organisation at all nuclear facilities and coordinated with the transport activities of fissile material and we report to the IAEA and other control Organisations as required.

5. Conclusions

The transport of radioactive materials – fissile and others – is a vital link in the nuclear activities and required worldwide. For the short term, there are bottlenecks in the availability of certified casks complying with the actual regulations. It is necessary that the nuclear regulatory authorities response with flexibility, in order to grant adequate transition time for new casks to be operated.

An increasing set of standards, regulations, procedures, legal requirements, etc. leads today to highly regulated transport processes. An effort to optimise the amount of paperwork is required, in order to keep the transport process transparent and efficient.

Because of limitations in cask availability, it might be useful to share casks with different owners; nevertheless there is the requirement of extended validations for the transit and user countries and the time required to obtain them.

PSI has transport packages of type A , as well as casks of type B (U) F-85 and B (U)-85 adequate for small fuel quantities; PSI uses currently various larger casks e.g. R-52, TN6, PADIRAC RD 25 II B, TNB-Casks etc. which are used also at various Swiss nuclear power stations and research facilities abroad. Some interim storage facilities are available at the institute.
Air transport restrictions, added to the lack of type C casks or acceptable type B (U) casks, limit also the transport of MOX fuel. Some road/sea transport developments show potential limitations in Europe and require specific clarifications in order to avoid complications in the timing and compliance of important international projects.

Nuclear transport into and from Belgium

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Introduction

Since more than fifty years, activities in Belgium related to the nuclear area have been developed with success. It began with the Research Centre of Mol and its reactors and laboratories, to continue with the construction of Power Plants, Waste treatment installations, fuel production, etc…

Consequently and also due to the central position of Belgium in Europe, more and more nuclear transports have to be executed to, through and from Belgium.

The first part of the presentation will describe the most important flux of nuclear transport.

The second part will give an overview of the SCK procedure for transport of nuclear material. The SCK radiation protection department introduced a document "Model 151" that always is used as key document for internal and external nuclear transports.

A summary is given of the supplementary documents to be completed to arrange a nuclear transport in accordance with the European directives and the national legislation

1. Flux of nuclear transport to and from Belgium

Belgian transport companies are executing a lot of different nuclear transports.
In this presentation we will try to give an overview of the most important transports executed now in Belgium by dividing the transports in 5 categories :

1. Upstream of the fuel cycle.
2. Fresh fuel.
3. Downstream of the fuel cycle.
4. Wastes and dismantling.
5. Research, Laboratories and Medical.

For each category, every flux is described as follows :

1. Country from which the transport is coming.
2. Installation from which the transport is coming.
3. Nuclear material transported.
4. Between ( ), package used for this transport.

Also transports through Belgium without intervention in Belgium are mentioned in the flow charts.

1.1. Upstream of the fuel cycle (Figure 1)

The materials concerned are U_30_8, $U_{natural}$, $U_{depleted}$, sodium diuranate, uranium hexafluoride. Most of these transports are only transiting Belgium coming from or going to ore extraction plants, transformation and enrichment installations, fresh fuel production plants.

Anyway, for these transits, transport authorizations and other administrative formalities are to be foreseen.

A lot of those transits are due to the important traffic in the Antwerp port.

1.2. Fresh fuel (Figure 2)

a) UO_2 fuel
Uranium fuel bundles are produced in Belgium by the FBFC facility. UO_2 pellets are imported from other countries and bundles are sent to EDF, Ringhals and Electrabel. Uranium bundles are also imported to Electrabel power plants from France, Sweden, Spain and Germany.

b) MOX fuel

Pu from La Hague and depleted or natural uranium oxide from Germany, France, Sweden and Brazil are imported to BN MOX fabrication plant. The MOX rods are sent from BN Dessel to FBFC and MOX bundles are sent to Germany, Switzerland and Belgium.

c) MTR fuel to BR2 is coming from France.

1.3. Downstream of the fuel cycle (Figure 3)

Spent fuel coming from Belgian power plants are handled as follows :

Doel spent fuel is stored in TN24 storage/transport casks in a building on the site.

Tihange spent fuel is transported for Ti 1, 2 and 3 power plants to a storage pool with the TN17T cask.

Spent fuel coming from the dismantled BR3 plant is stored in 6 Castor casks at Belgoprocess.

BR2 spent fuel is sent to the La Hague reprocessing plant in the TN-MTR cask.

Also spent fuel for the Borssele plant in the Netherlands is sent to La Hague with the TN17-2 cask through Belgium.

1.4. Waste production and dismantling (Figure 4)

In Belgium, all the nuclear waste produced is managed by NIRAS/ONDRAF and the exploitation of the centralized treatment and storage installations is executed by Belgoprocess.

The waste produced by the NPP, SCK and BN-Dessel is treated (or pre-treated) on site and transported in drums or containers by using specific TNB shielded containers.

Waste coming from maintenance of main components of NPP is sent back to the NPP.

Vitrified waste coming from fuel reprocessing in La Hague is sent back to Belgoprocess with the TN28 package.

1.5. Research, laboratories and medical (Figure 5)

The activities of LMHA hot cells in the SCK concerning analysis of spent fuel (rods), irradiated samples and core plates and the production of irradiated sources by BR2 need a lot of transports from and to everywhere in Europe using specific packages.

Samples, rod segments, plates	using TNB145, TN5, TN6 or D14000
Full length fuel rods	using BG18
UMO plates and Pu sources	using TN-BGC

Irradiated targets and sources are sent to IRE at Fleurus with AGNES, …. SCK, IRMM, FBFC and BND send samples to the International Atomic Energy Agency for controls.

1.6. Transport authorizations

All the transport authorizations for nuclear transport are delivered in Belgium by the FANC (Federal Agency for Nuclear Control).
The international regulations followed and the SCK internal procedure are described in the second part of this presentation.

Figure 1 Upstream of the fuel cycle

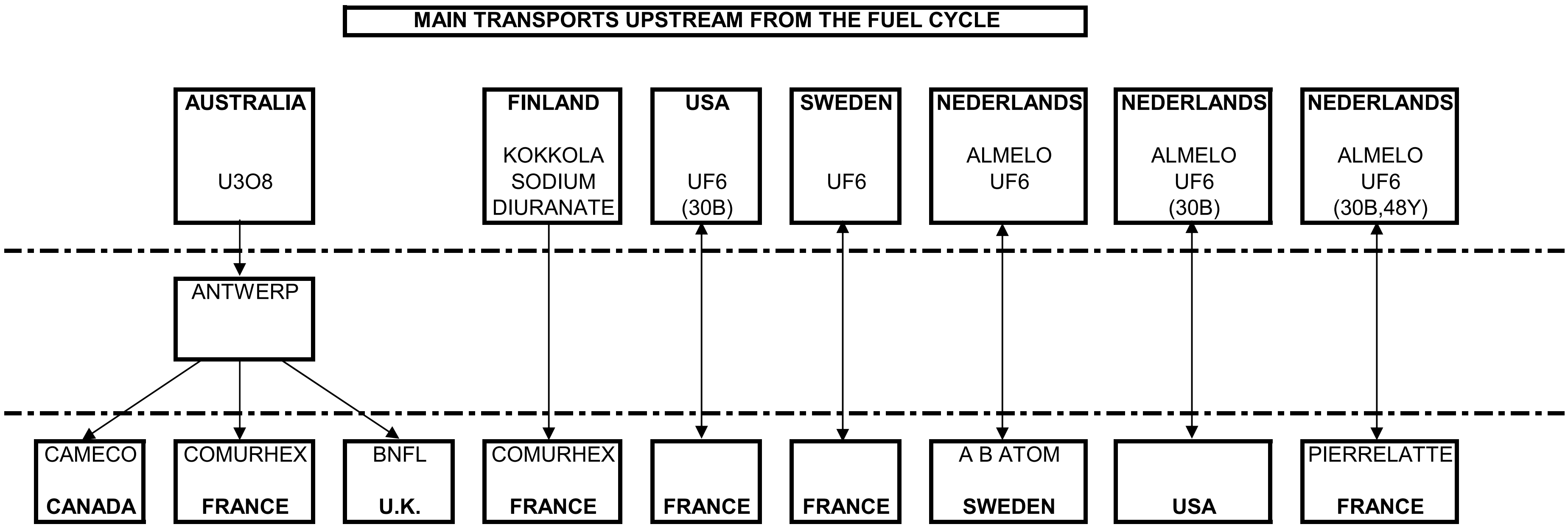


Figure 2 Fresh Fuel

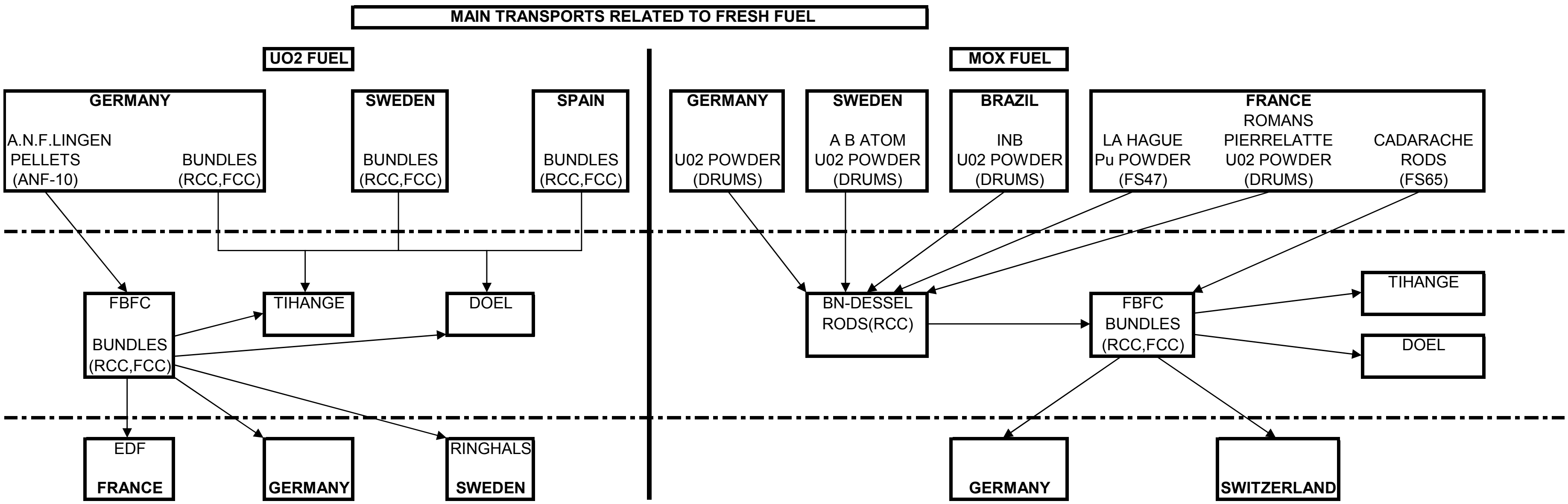


Figure 3 Downstream of the fuel cycle

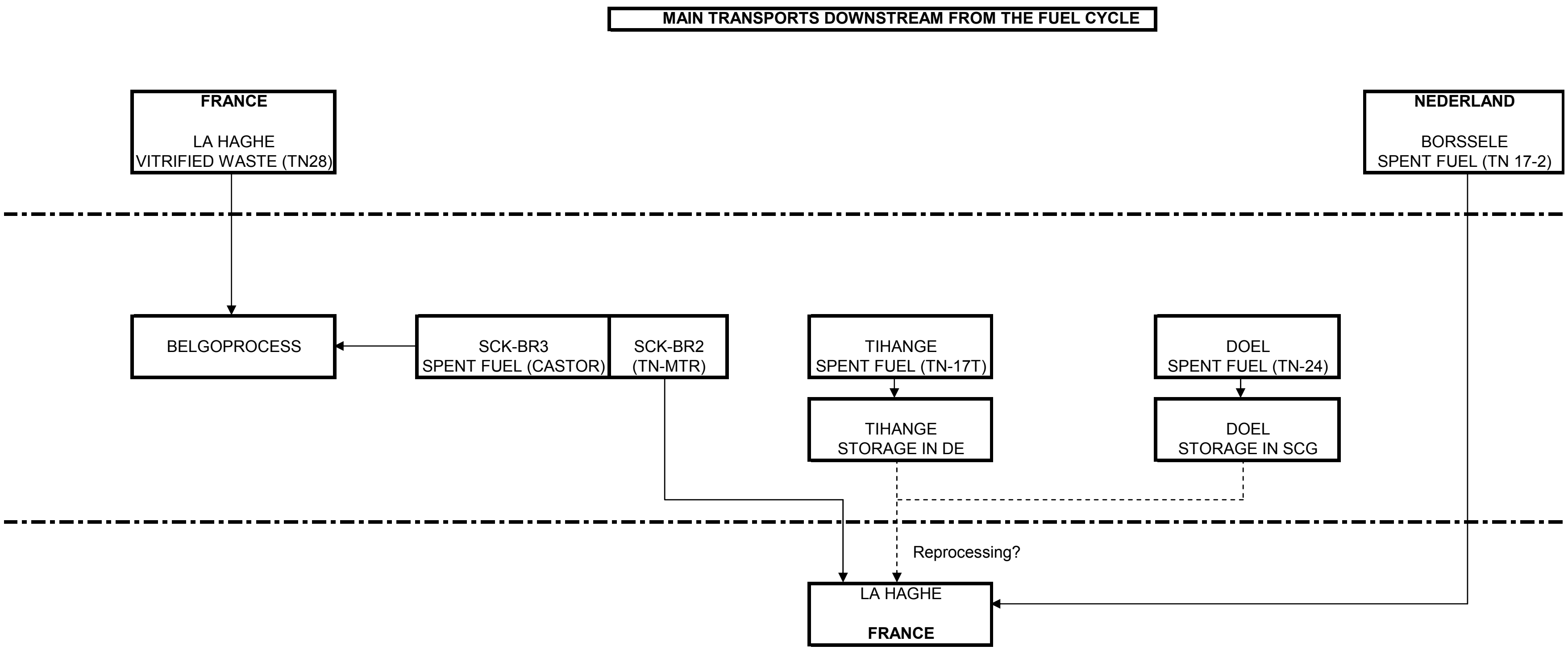


Figure 4 Waste production and dismantling

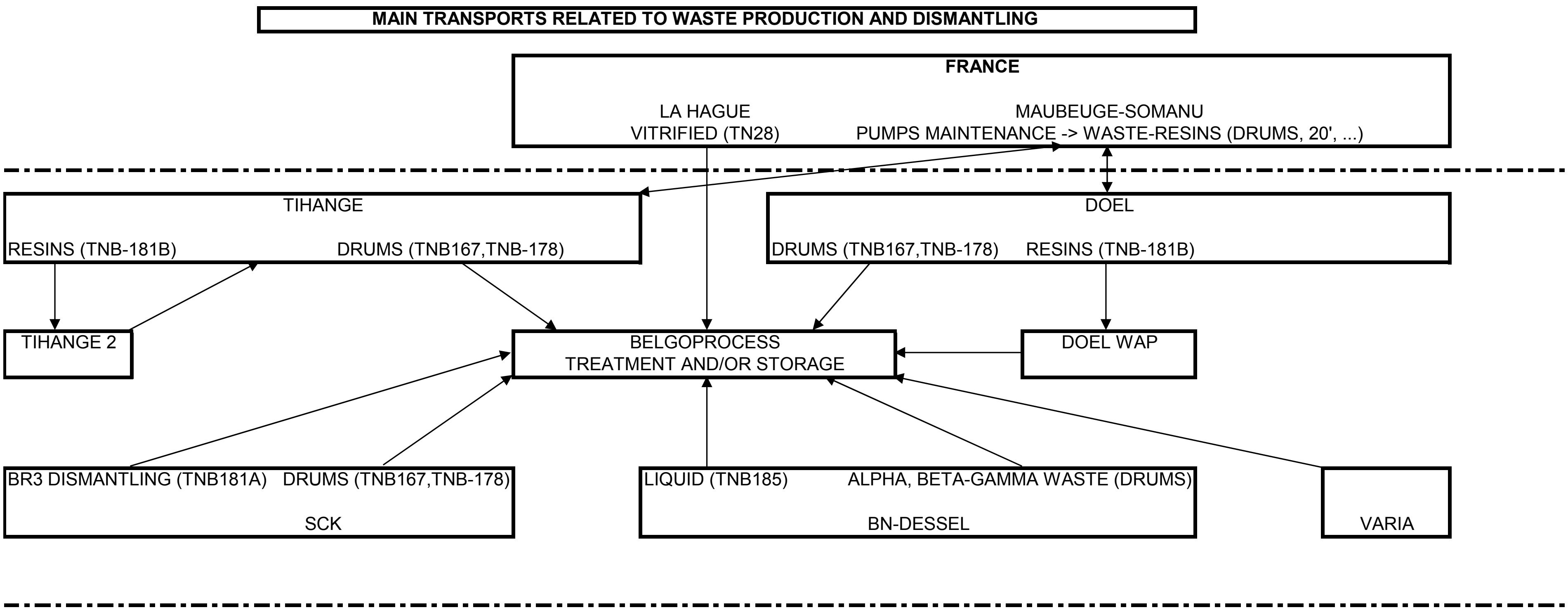
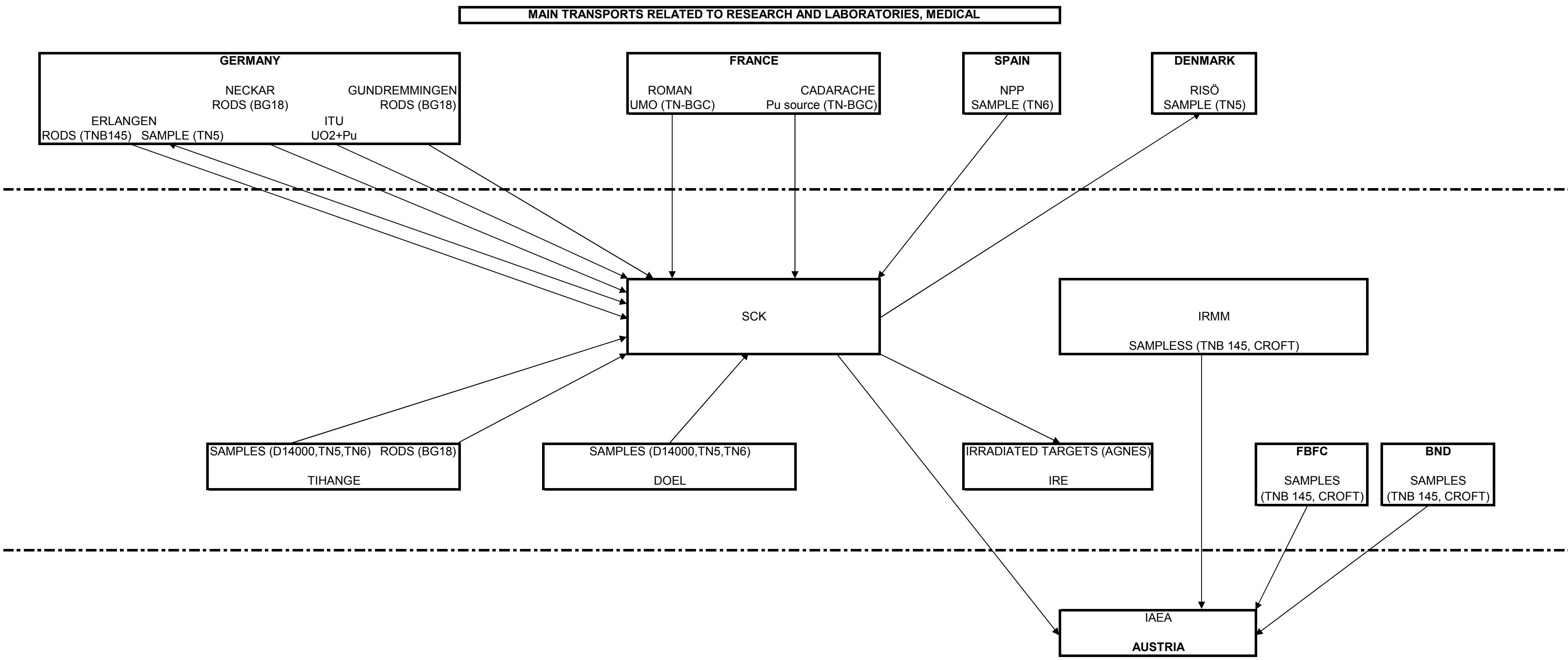


Figure 5 Research, Laboratories and medical



2. Model 151 document (Figure 6)

“Transport of nuclear materials”
The coordinator has to complete as much as possible the document before sending it to the radiation protection transport officer.

Once the document is completed and the transport is approved by the radiation protection officer the coordinator has the permission to execute the transport.

This document is internal distributed to the several departments involved with the transport.

a) Radiation protection agent of the building where the material shall be send away or accepted
b) Radiation protection transport officer
c) Entrance control at the main gate
d) Fuel account in case for fuel transport
e) Insurance officer

The back-side of the document is a summary of the transport conditions of the container and the transport vehicle.

Figure 6 Model 151

STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

TRANSPORT OF RADIOACTIVE MATERIALS

Ph C nr:

1. Date of transport:
2. Consignor:
3. Consignee:
4. Carrier:
5. Custom-House for import:
6. Informaton about the goods: ☐ road ☐ rail ☐ air ☐ sea
   A. General description:
   B. Isotopic Composition:
   C: Chemical form:
   D: Physical form: ☐ solid ☐ liquid ☐ gas ☐ special form ☐ low dispersible
   E: Activity: Bq
   F: Fissil materials: ☐ NA
   - Uranium: Unat: g Plutonium: Tot weight: g
     U^{235}enrich: % Pu^{238}: %
     U^{235}: g Pu^{239}: %
     Pu^{240}: %
     Pu^{241}: %
7. Residual heat: W (highly activated materials or used fuel)
8. Package information:
   ☐ type A ☐ type B(U) ☐ type B(M) ☐ type C ☐ Industrial ☐ Exempt
   package identity:
   package approval:
   number of packages:
9. Documents:
   Tranport Licence: ☐ particular ☐ general ☐ special Number:
   Special form certificate:
   Fissil materials approval:
   Insurance:
   Import/Transit licence:

"I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labelled/placarded, and are in all respects in proper conditon for transport according to applicable international (governmental) regulations."

10. Coordinator: Tel: 32(0)14.33. e-mail:

☐ I-white ☐ II-yellow ☐ III-yellow Index:
CSI:

11. a : Authorities to contact: Radiation Protection + ☐ AVN + ☐ FANC +
    b: Radiation protection at departure or arrival:
    c: UN code and proper shipping name:

Ph.C Authority: Date:

PBW & FC	Model 151: TRANSPORT OF RADIOACTIVE MATERIALS		
Editie: 2001	FG	FJ	Filename: Model 151.doc
Date: 2001-01-31	Opsteller: F. Geenen	Goedkeuring: F. Joppen	Page1/1

2.1. General information

- Date of transport
- Consignor
- Consignee
- Carrier

2.2. Custom-House for import

a) Road

Inland: Turnhout[(1)(3)], Zaventem[(2)]
Customs post offices: Hauser (Raeren), Eynatten (Raeren), Sankt Vith, Beaubru (Bouillon), Heer-Agimont (Hastière), Brûly (Couvin), Erquelinnes, Havay (Quévy), Hensies, Lamain (Doornik), Rekkem (Menen), Abele (Poperinge)

b) Rail

Inland: Turnhout, Zaventem
Customs post offices: Montzen (Plombières)[(3)], Herbesthal (Station)(Lontzen), Erquelinnes, Quévy, Moeskroen[(3)]

c) Sea and river

Antwerpen[(3)], Gent[(3)], Zeebrugge (Brugge)[(3)], heer-Agimont (Hastière), Erquelinnes

d) Air

Zaventem, Gosselies (Charleroi)[(3)], Oostende (Middelkerke)[(3)]

(1): office only open for the import of products by companies established by the province of Antwerp.

(2): office only open on the condition that the import of the materials is allowed in the general or special license

(3): office only open for the import of radioactive appliance and materials what will not be sent to an storage neither to a particular storage of a public storage

2.3. Information about the radioactive material

To be completed if applicable

2.4. Residual heat

Highly activated materials or used fuel

2.5. Package information

The following types of packages are used for radioactive material.

2.5.1. Excepted packages

Four possibilities:

- Radioactive materials in limited quantities.
- Instruments and manufactured articles.
- Articles manufactured from natural uranium or depleted uranium or natural thorium.
- Empty packages.

Excepted packages are not subject to the provisions relating to:
- categorization, packages, packing, marking, labeling, shipper's declaration, … provided that:

  - they comply with general conditions ex. radiation level at any point on the external surface of the excepted package does not exceed 5 µSv/h;
  - the activity falls within the limits of following table.

	Instruments & Articles		**Materials**
Nature of contents	**Item limits**	**Package limits**	**Package limits**
Solids			
Special forms*	$10^{-2}A_1$	A_1	$10^{-3}A_1$
Other forms**	$10^{-2}A_1$	A_2	$10^{-3}A_2$
Liquids	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
Gases			
Tritium	$2 \times 10^{-2}A_2$	$2 \times 10^{-1}A_2$	$2 \times 10^{-2}A_2$
Special form	$10^{-3}A_1$	$10^{-2}A_1$	$10^{-3}A_1$
Other form	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A_2$

* Special Form: Special Form radioactive material is either an indispersible solid radioactive material or a sealed capsule containing radioactive material.
**Other Form: Radioactive material that does not meet the definition of special form

2.5.2. Industrial packages

Can be used for:
- Low Specific Activity (LSA) Material: radioactive material which by its nature has a limited specific activity or radioactive material for which limits of estimated average specific activity apply Three Group: LSA-I/LSA-II/LSA-III
- Surface Contaminated Object (SCO): Means a solid object which is not itself radioactive, but which has radioactive material distributed on its surfaces. Two groups: SCO-I and SCO-II.

Use of Industrial Packaging:

	Industrial package type	
Contents	Exclusive use *	Not under exclusive use
LSA-I		
Solid	**Type 1**	**Type 1**
Liquid	**Type 1**	**Type 2**
LSA-II		
Solid	**Type 2**	**Type 2**
Liquid and	**Type 2**	**Type 3**
LSA-III	**Type 2**	**Type 3**
SCO-I	**Type 1**	**Type 1**
SCO-II	**Type2**	**Type 2**

* Exclusive use: The sole use by a single shipper of an aircraft or of one or more large freight containers with a minimum length of 6 m, in respect of which all initial, intermediate and final loading and unloading is carried out in accordance with the directions of the shipper or consignee. Any residual space may be utilized by such shipper only for other non-radioactive material.

2.5.3. Type A packages

Type A packaging are used when the activity and/or the radiation limits for excepted materials have been exceeded.

A type A package must not contain activities greater than the following:

- for special form radioactive material: A_1
- for all other radioactive material: A_2

For example: Ir 192 A_1 1 TBq
A_2 0,6 TBq

Type A packages are intended to provide a safe, economical means for transporting relatively small quantitities of radioactive material. These are expected to retain their integrity under conditions that may occur during transport: falling from surface vehicles, being exposed to rain, being struck by a sharp object, which may penetrate the package or having other cargo stacked on top.

It is assumed, however, that type A packages may be damages in a severe accident and that a fraction of the contents may be released.

Limits are therefore prescribed in the Regulations for the maximum activities of radionuclides that can be transported in Type A packages. These limits ensure that in the event of a release, the risk of external radiation or contamination are low.

For larger amounts of radioactive material, a Type B package is required.

Type A packages do not require government approvals unless they are used for fissile materials. If the radionuclide is in Special Form, a Special Form approval certificate is required.

2.5.4. Type B packages

a) A type B package must not contain:

  - Activities greater than those authorized for the package design;
  - radionuclides different from those authorized for the package design or;
  - contents in a form, or a physical or chemical state different from those authorized for the package design;

as specified in the certificate of approval.

b) Type B(U) and Type B(M) packages, if transported by air, must meet the requirements of a) and must not contain activities greater than the following:

  1. for low dispersible radioactive material – as authorized for the package design as specified in the certificate of approval;
  2. for special form radioactive material – 3000 A_1 or 100 000 A_2 whichever is the lower or;
  3. for all other radioactive material – 3000 A_2.

c) Type B(U) needs unilateral approval, i.e. approval by the competent authority of the State of origin except that:

   1. a type B(U) package design for fissile material must require multilateral approval;
   2. a type B(U) package design for low dispersible material must require multilateral approval.

   Type B(M) needs multilateral approval.

d) All type B packages must comply with the requirements for Type B Packages.

The following 8 tests will be carrying out on the container:

1. shielding test;
2. criticality;
3. impact;
4. drop;
5. mechanical resistance;
6. heat approval;
7. leaktest;
8. design and construction.

Other security measures:

- the container has to be sealed;
- the container has to be brand along outside on readable and permanent way with:
  - mark of identity, granted by the competent government;
  - serial number so each package of the same model could be recognized;
  - the terms TYPE B (U) of TYPE B(M) of TYPE B(U)F of TYPE B(M)F;
  - cloverleaf wrought or marked on the outside covering resist against water and fire.

2.5.5. Type C packages

Type C packages may be transported by air carrying radioactive material in quantities exceeding either 3000 A_1 or 100 000 A_2, whichever is the lower for special form radioactive material, or 3000 A_2 for all other radioactive material. Whilst Type C packages are not required for carriage of radioactive material by road in such quantities (Type B(U) or Type B(M) packages suffice), the following requirements are presented since such packages may also be carried by road.

Type C packages shall not contain:

a) Activities greater than those authorized for the package design;
b) Radionuclides different from those authorized for the package design or;
c) Contents in a form, or physical or chemical state different from those authorized for the package design;

as specified in their certificates of approval.

Each type C package design shall require unilateral approval except that a package design for fissile material shall require multilateral approval.

2.5.6. Packing identity

For example: TN6-1, BG 18, MTR

2.5.7. Packing approval

For example

D / 4197 / B(U) F-85 rev. 2

Country of origin — unique number for this containers — type of approval (AF, B(U), B(M), FF, S, T, X)

- AF: type A for fissile material
- B(U): type B uni-lateral approval
- B(M): type B multi-lateral approval
- IF: industrial for fissile material
- S: radioactive material in a special form
- T: transport
- X: special agreement

2.6. Documents

2.6.1. Transport license

There are three type of licenses.

2.6.1.1. General license

Authorized to transport companies for regular transport of radioactive material during max 5 years the license can be extended.

2.6.1.2. Particular license

Authorized to a transport company to transport only once radioactive material.

2.6.1.3. Special license

Authorized for only one transport arrangement that exceeded the limits of the general and particular license. Within the same special license more than one transport of a loaded container is allowed. We have three classes of special license:

Klasse 0: no special requirements.

Klasse III: presence of two drivers is required in the truck.

Klasse II: presence of two drivers is required in the truck and the transport is accompanied by a vehicle equipped with intervention material.

Klasse I: presence of two drivers is required in the truck and the transport is accompanied by a vehicle equipped with intervention material. Supervision by the police during the transport and permanent radiocontact between the vehicle and the central communication centre is obliged.

RIS/7 S.015.BG.02.098

RIS: Radiation Ionistantes
6: import
7: transport
A : general license
B : particular license
S : special license
SI : special license international
015 : identification of the license holder

BG: letter code indicating the difference between the licenses of the license holder
02: year of approval
098: rank number of the license

2.6.2. Transport insurance

Always required for each transport, certificate of financial guarantee.

2.6.3. Determination of the category

Category	Transport index	Maximum radiation level at any point on external surface at 1 m distance
I-white	0	Not more than 5 µSv/h (0.5 mrem/h)
II-Yellow	More than 0 but Not more than 1	More than 5 µSv/h (0.5 mrem/h) but not more than 500 µSv/h (50mrem/h)
III-Yellow	More than 1 but Not more than 10	More than 500 µSv/h (50 mrem/h) but not more than 2 mSv/h (200 mrem/h)
III-Yellow and under exclusive use	More than 10	More than 2 mSv/h (200 mrem/h) but not more than 10 mSv/h (1000 mrem/h)

Except for consignment under exclusive use the transport index of any individual package or over pack must not exceed 10. In addition for fissile material the criticality safety index of nay package or over pack must not exceed 50. The CSI may be zero.

2.7. Back side document 151 control by arrival or departure (Figure 7)

Always to be completed before the truck leaves the SCK site.

Figure 7 Back side document 151

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Ph C nr **:**

To be completed by radiation protection agent

13 DEPARTURE - ARRIVAL

Date : Hour : .

14 Category of package :

I-WHITE ☐
II-YELLOW ☐
III-YELLOW ☐

15 ☐ **C**riticallity **S**afety **I**ndex:

☐ Transportindex :

16 Dose rate measurements : Unit : µSv/h : ☐ mSv/h : ☐

Maximum in contact with the package ☐

Maximum in contact with the vehicle ☐

Maximum at 2 m distance from the vehicle ☐

Maximum on drivers seat ☐

17 Contamination controle :

Removable α– contamination on package : Bq/dm^2

Removable βγ- contamination on package : Bq/dm^2

Controle of cargo space : .

18 Documents available ? ☐ Yes ☐ No

19 Labelling of the package conform the category? ☐ OK

20 Labelling of the truck and cargo space closed
en werd de laadruimte afgesloten ? ☐ OK

21 License plate of truck :

22 Remarks :

Operator : **SKV-**

Name :

STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Figure 8

Transfer of nuclear fuel materials towards SCK•CEN - LHMA

Informations

Following informations are to be provided by the consignor to the SCK•CEN in order to cope with the internal SCK•CEN, Belgian and international procedures.

Transfer data	
Consigner	....
Code of the installations	.... (in accordance with Euratom)
Consignee	SCK•CEN – LHMA Boeretang, 200 B-2400 Belgium
Code of the installations	WCRM
Identification of material	"fuel rods [rod no.] – (U,Pu)O_2 pellets [batch no.] - ...."
Number of articles	......
Description of material	.... (code Euratom or IAEA)
Code of the engagement	.........................(code Euratom or IAEA)
Irradiated fuel data	
Elements	"U, Pu(,Th)"
Total weigth (after irradiation)	U = x,xxx g (Th = z,zzz kg) Pu = y,yyy g
Isotopic Composition (after irradiation)	U : ^{233}U = ... % ^{235}U = ... % ^{238}U = ... % Pu : ^{238}Pu = ... % ^{239}Pu = ... % ^{240}Pu = ... % ^{241}Pu = ... % ^{242}Pu = ... %
Total activity	.... Bq (at date ....)
End of irradiation date	"yyyy-mm-dd"
Burnup	.... GWd/t_M
Reactor type	"PWR – BWR"
Fresh fuel data (also to be filled in for irradiated fuel, i.e. the data before irradiation)	
Fuel type	"UO_2 – (U,Pu)O_2"
MOX enrichment	[Pu]/[U+Pu] = ... %

Isotopic Composition (before irradiation)	U : ^{233}U = ... % ^{235}U = ... % ^{238}U = ... %	Pu : ^{238}Pu = ... % ^{239}Pu = ... % ^{240}Pu = ... % ^{241}Pu = ... % ^{242}Pu = ... %

In case the transport contains different materials with different characteristics, an information sheet should be completed for each type of material.

3. Additional information

3.1. Transfer of nuclear fuel materials towards SCK•CEN – LHMA (Figure 8)

All this information has to be provided by the consignor of the fuel, before the shipment, in order to make it possible for the consigner to:

- inform the safeguard correctly;
- have irradiated fuel data used for the waste characterisation program "CARAFVAL";
- check the transfer data after the unloading of the container.

3.2. European regulation N° 1493/93 and 92/3

Those regulations shall apply the shipments between Member States of sealed sources, other relevant sources and waste.

The request for a license is remarkable different for transport of encapsulated sources and other relevant sources. Always try to use "the relevant source" if possible.

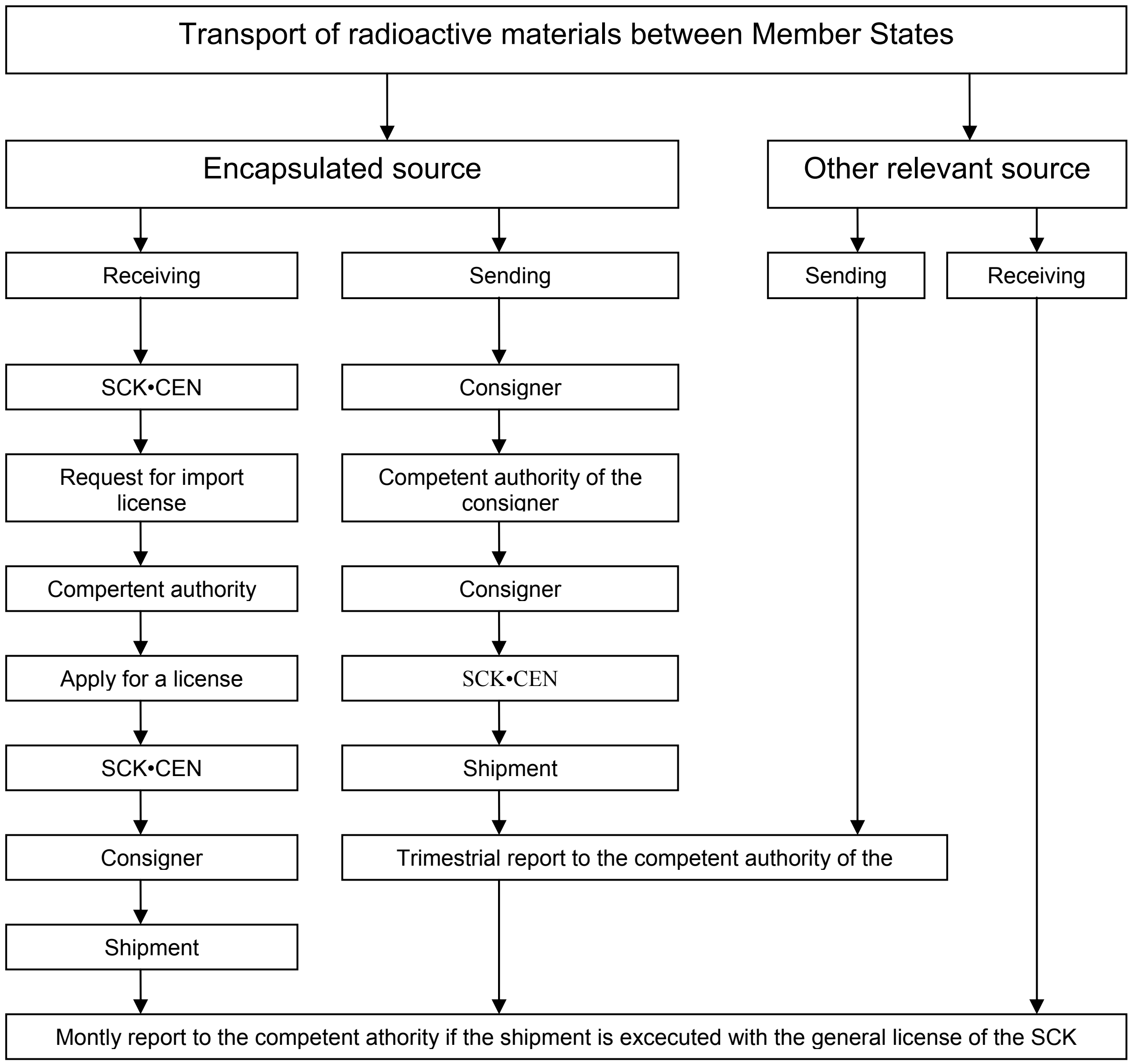
Sealed source

Radioactive material that is permanently sealed in a capsule or closely bounded and in solid form. The capsule or material of a sealed source shall be strong enough to maintain leaktightness under the conditions of use and wear for which the source was designed, also under foreseeable mishaps.

Relevant source

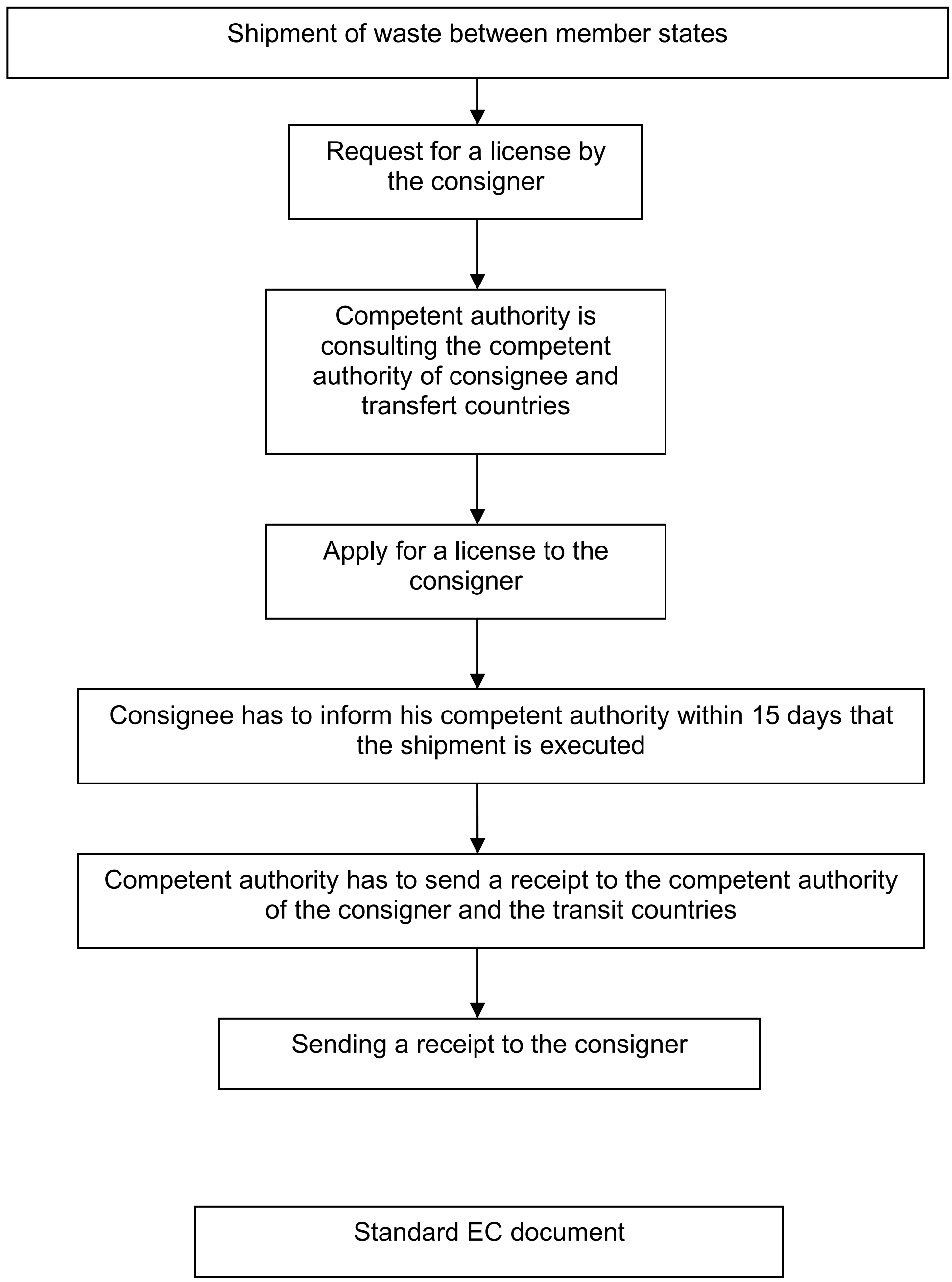
Any radioactive substence seat being a sealed source intented for direct or indirect use of the comising radiation.

3.3. Shipment of encapsulated and sealed sources European regulation N° 1493/93



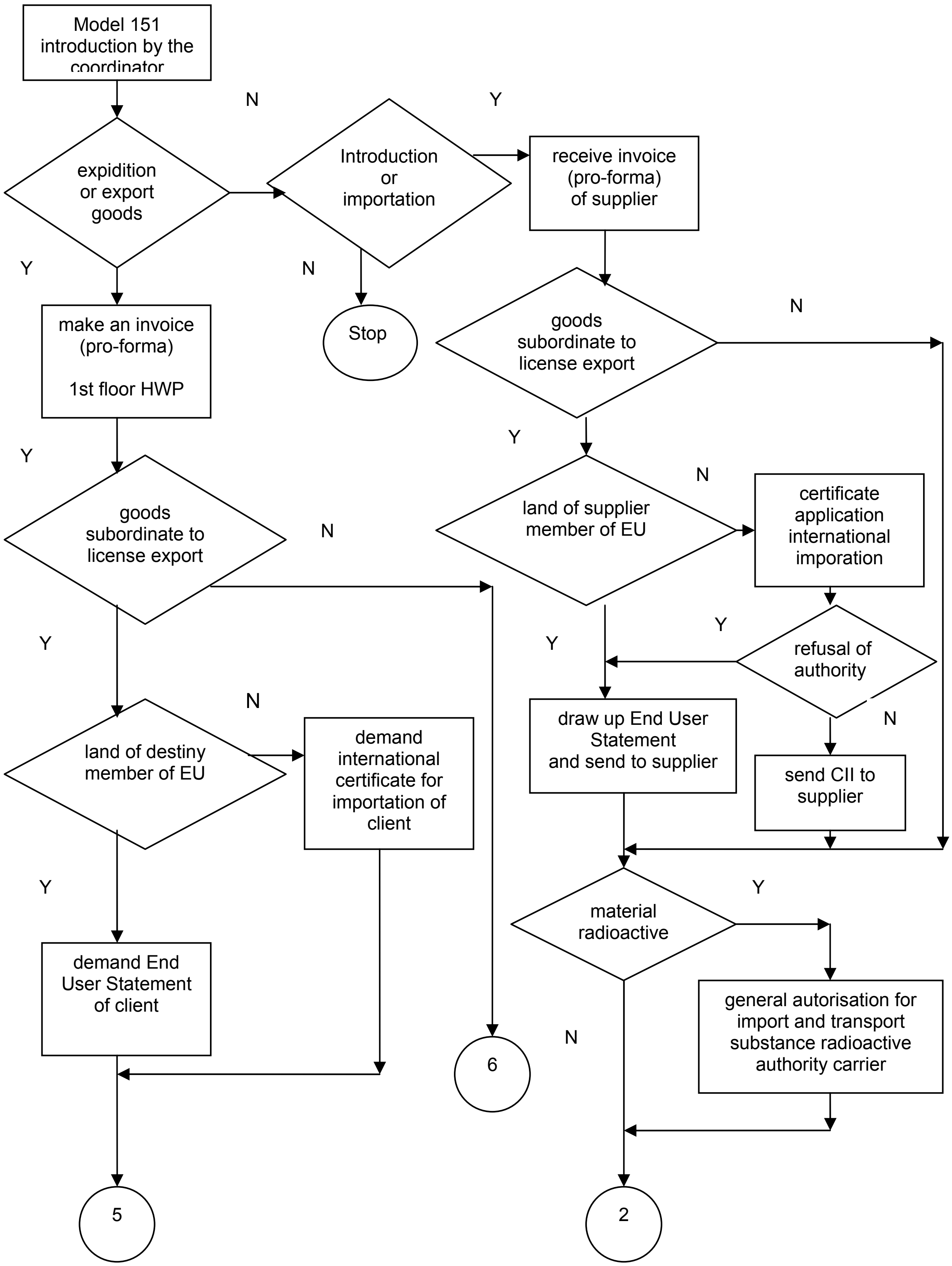
3.4. *Shipment of waste (92/3)*

The flow chart for the shipment of waste between EC countries is totally different from the flow chart for sources (see 3.3)

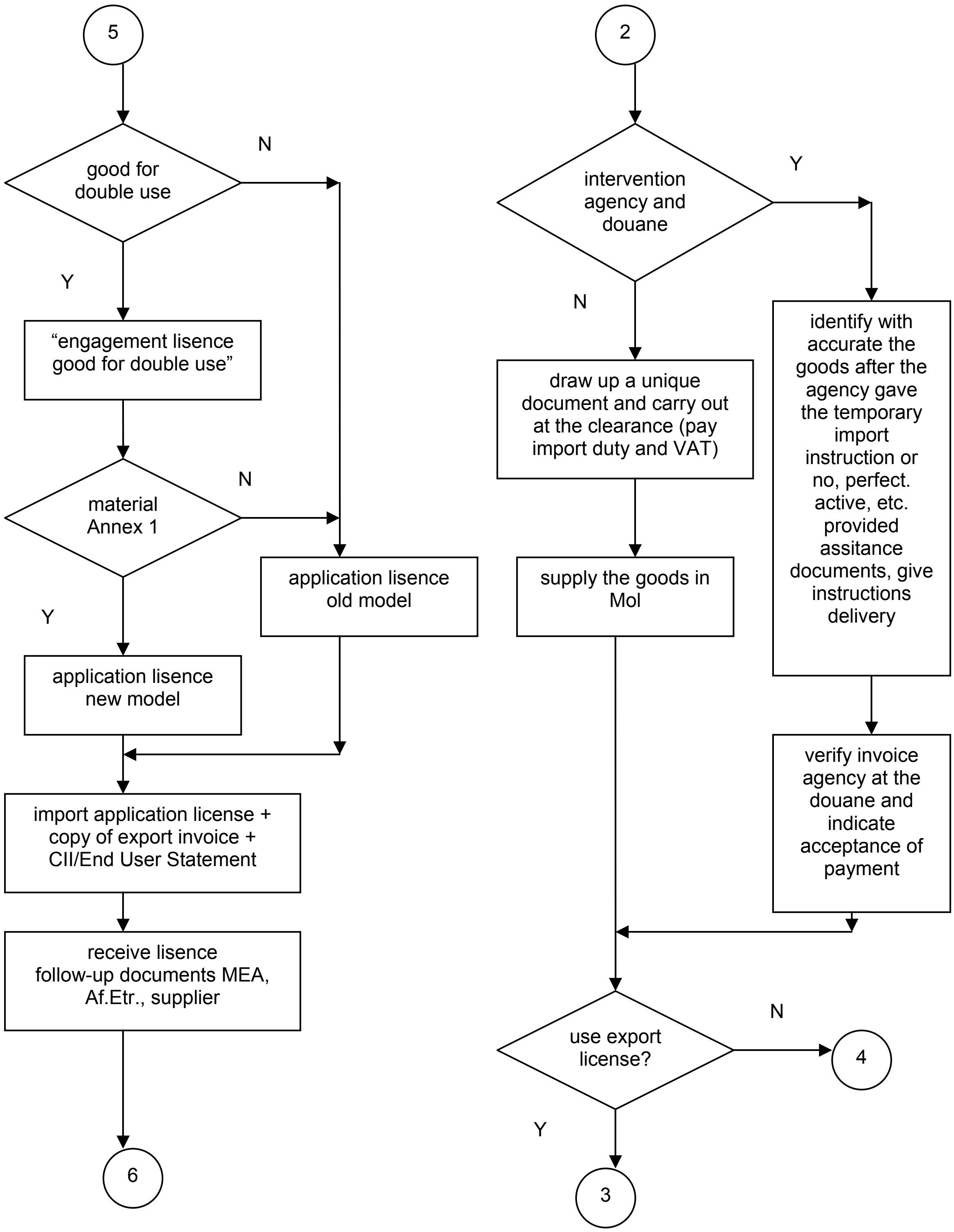


3.5. *Flow-chart of the SCK•CEN import-export QA procedure*

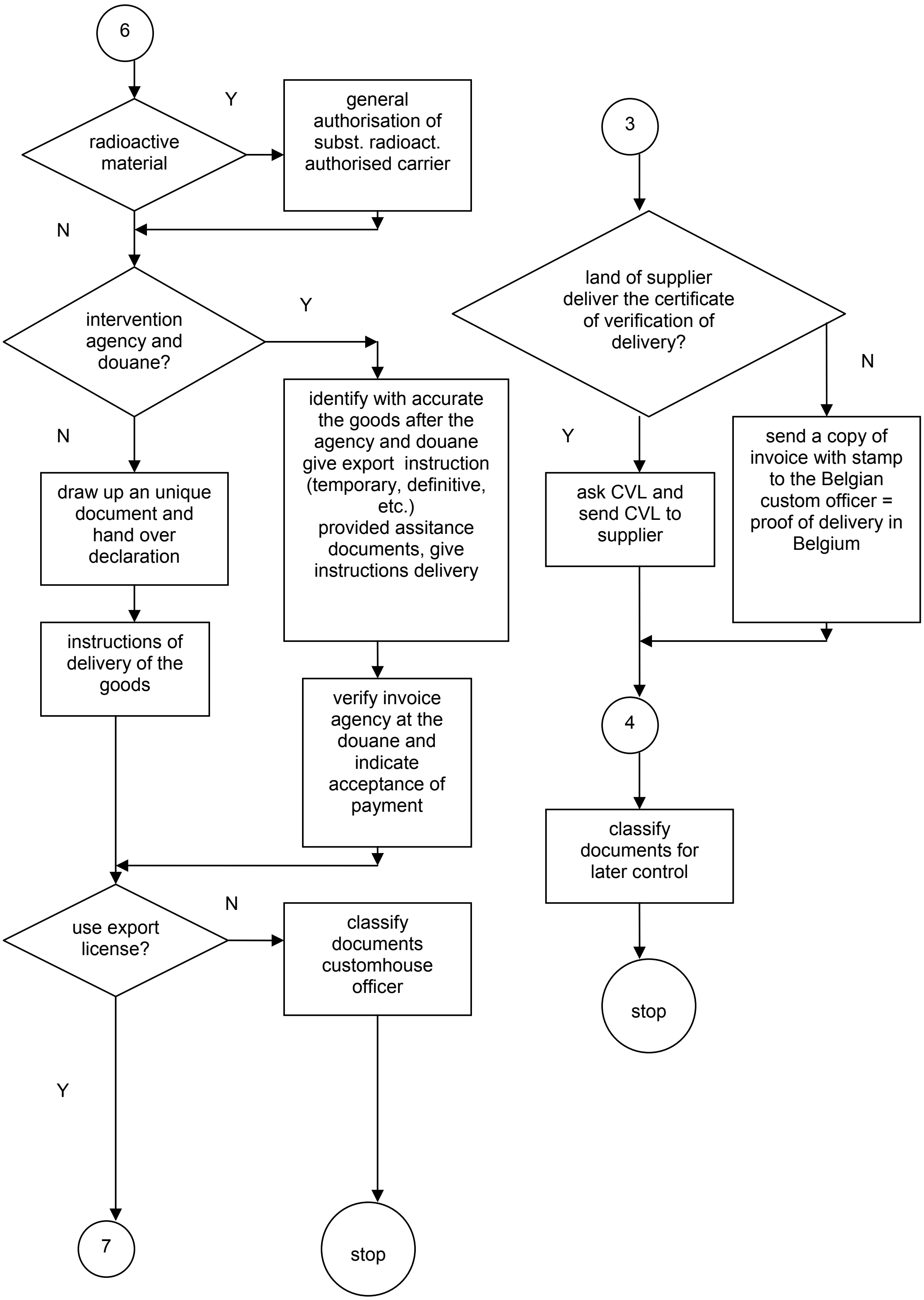
This flow-chart gives an impression of the amount of work to do between the moment that the coordinator has send his request to the radiation protection officer and the final approval for the transport of radioactive material.


Model 151
introduction by the
coordinator
expidition
or export
goods
Introduction
or
importation
receive invoice
(pro-forma)
of supplier
Stop
make an invoice
(pro-forma)
1st floor HWP
goods
subordinate to
license export
land of supplier
member of EU
certificate
application
international
imporation
refusal of
authority
draw up End User
Statement
and send to supplier
send CII to
supplier
land of destiny
member of EU
demand
international
certificate for
importation of
client
material
radioactive
general autorisation for
import and transport
substance radioactive
authority carrier
demand End
User Statement
of client
6
5
2
Y
N

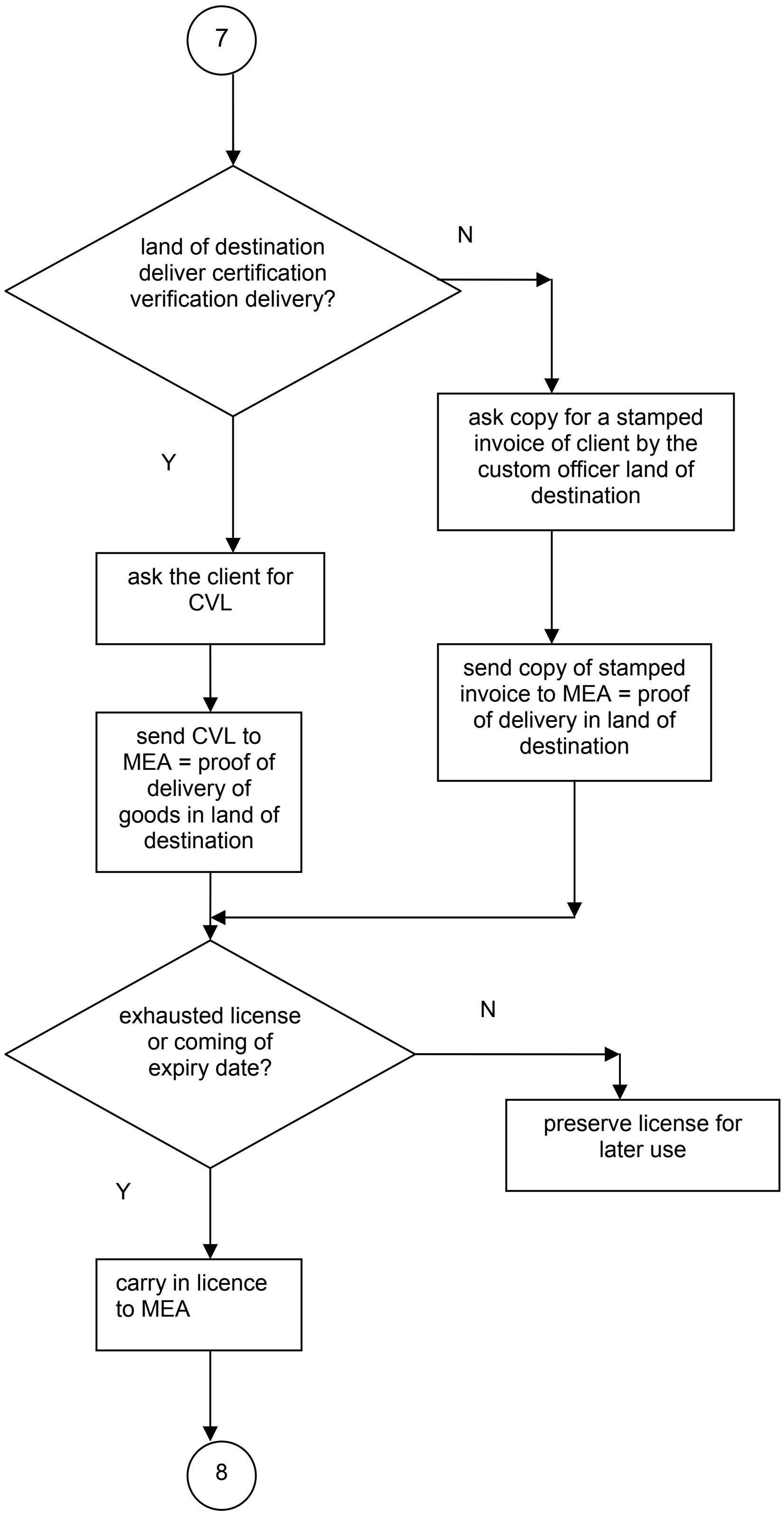
*CII: International import certificate
*MEA: Ministry of Economic Affairs
*Af. Etr.: Ministry of Foreign Affairs
*CVL: certificate of verification of delivery


5
good for double use
N
Y
“engagement lisence good for double use”
material Annex 1
N
Y
application lisence old model
application lisence new model
import application license + copy of export invoice + CII/End User Statement
receive lisence follow-up documents MEA, Af.Etr., supplier
6
2
intervention agency and douane
Y
N
draw up a unique document and carry out at the clearance (pay import duty and VAT)
identify with accurate the goods after the agency gave the temporary import instruction or no, perfect. active, etc. provided assitance documents, give instructions delivery
supply the goods in Mol
verify invoice agency at the douane and indicate acceptance of payment
use export license?
N
4
Y
3

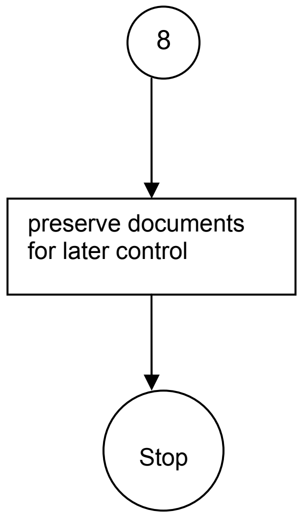
*CII: International import certificate
*MEA: Ministry of Economic Affairs
*Af. Etr.: Ministry of Foreign Affairs
*CVL: certificate of verification of delivery


6
radioactive material
Y
general authorisation of subst. radioact. authorised carrier
N
intervention agency and douane?
Y
identify with accurate the goods after the agency and douane give export instruction (temporary, definitive, etc.) provided assitance documents, give instructions delivery
N
draw up an unique document and hand over declaration
instructions of delivery of the goods
verify invoice agency at the douane and indicate acceptance of payment
use export license?
N
classify documents customhouse officer
Y
7
stop
3
land of supplier deliver the certificate of verification of delivery?
Y
ask CVL and send CVL to supplier
N
send a copy of invoice with stamp to the Belgian custom officer = proof of delivery in Belgium
4
classify documents for later control
stop

*CII: International import certificate
*MEA: Ministry of Economic Affairs
*Af. Etr.: Ministry of Foreign Affairs
*CVL: certificate of verification of delivery


7
land of destination deliver certification verification delivery?
N
Y
ask copy for a stamped invoice of client by the custom officer land of destination
ask the client for CVL
send copy of stamped invoice to MEA = proof of delivery in land of destination
send CVL to MEA = proof of delivery of goods in land of destination
exhausted license or coming of expiry date?
N
preserve license for later use
Y
carry in licence to MEA
8

*CII: International import certificate
*MEA: Ministry of Economic Affairs
*Af. Etr.: Ministry of Foreign Affairs
*CVL: certificate of verification of delivery



*CII: International import certificate
*MEA: Ministry of Economic Affairs
*Af. Etr.: Ministry of Foreign Affairs
*CVL: certificate of verification of delivery

A New Generation in the Family of Packages for Transportation

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Abstract

A new generation of packages has been developed by COGEMA LOGISTICS to meet the various needs and requirements of the Laboratories and Research Reactors all over the world, following the 1996 Regulations.
A lot of packages existing till then had been used successfully for many years but could not comply to the changing regulatory context.

These new packages are adapted to various options, and are able to propose worldwide and long-term solutions for international transports of all kinds and sizes of materials from and to any site.

The **TN-UO2** is a stainless package meeting IAEA 1996 ST-1 requirements, type A fissile, which can be used to ship several kinds of non irradiated materials, including reprocessed uranium.

Its multipurpose design and internal equipment enables to accommodate with many different contents, such as UO2 powders, UO2 pellets, as well as wastes and metallic uranium up to 5% enrichment.

The TN-UO2 is rather a small package, user friendly, and easy to handle.
Its outer dimensions are : diameter 400 mm, and height 805 mm.
The cavity inner content dimensions are : diameter 260 mm, and height 580 mm.
The inner capacity is 23.7 liters.
Its maximum gross weight is 95 kg, and the maximum payload is 32.5 to 38 kg, depending on the enrichment.

The TN-UO2 is used today on a daily basis in Europe, with more than 600 packages owned by French Companies : FBFC, COGEMA LOGISTICS ...

The package has also just received a validation by the Authorities for air shipments.

Due to increasing needs of transport of higher enrichments, an extension of the existing agreement has been applied for solid uranium enriched up to 20%.

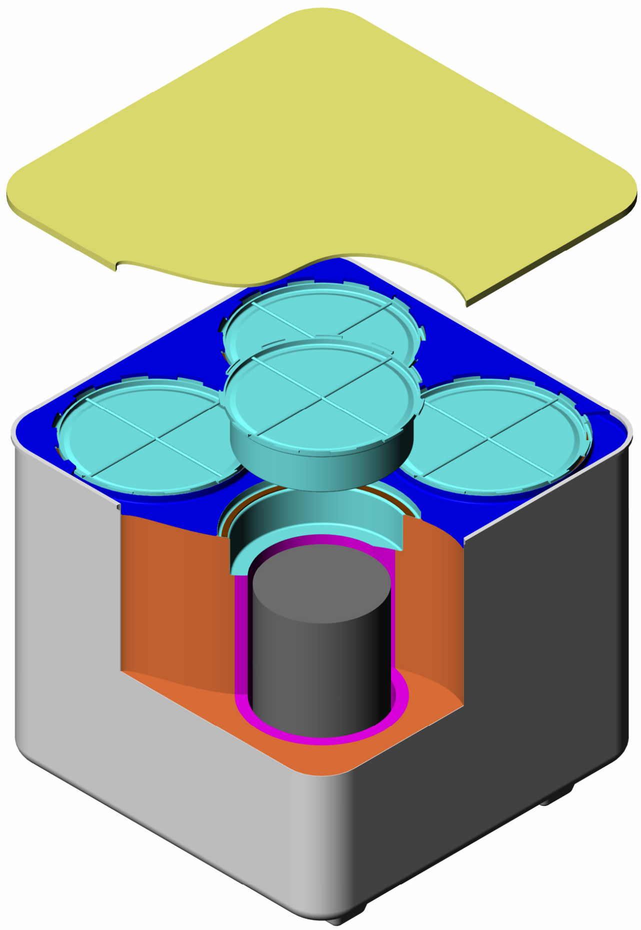
As there are also further needs for high-enriched uranium, another extension is expected for 2003 for metallic uranium with enrichments up to 95%, including air shipments.

The TN-UO2 is licensed in France, and validations are presently in progress in Belgium, the Netherlands, Germany, the United Kingdom, Sweden, the USA, and Canada.

The concept and the technology of the TN-UO2 can be versatile, and can be adapted to fit some specific needs or requests : a derivative version of the package, called TNF-XI, has been designed and manufactured to meet Japanese market specific requirements.

There are presently 800 of these TNF-XI packages to be used in Japan.

The TNF-XI package is already licensed in France, and its agreement or validation are in progress in Japan and the USA.



The **TN-MTR** is a B (U) F package which has been developed for the shipments of spent fuel of Research Laboratories.

The TN-MTR presents a cylindrical cavity, in which today 7 different kinds of baskets are available to comply with the characteristics of the spent fuel to be shipped.

The body is covered with cooling fins, and a shock absorber is fitted on the top of the package, in transport configuration. Up to 76 assemblies can be shipped in one package.

The outer dimensions of the package are : 1,610 mm height, and 1,600 mm diameter without the shock absorber.
With the shock absorber, the height is 2,080 mm and the diameter 2,008 mm.

The inner cavity has a diameter of 960 mm and a height of 1,080 mm.

The 7 different baskets which can presently be used are :

- RHF : with 3 cylindrical holes for RHF fuel,
- MTR-4 : with 4 cylindrical holes for inner containers of diameter 336 mm maximum,
- MTR-44 : with 44 square holes for elements,
- MTR-52 : with 52 square holes for elements,
- MTR-52-S : with 52 sleeved square holes for elements, especially designed for the USA,
- MTR-61 : with 61 square holes for elements,
- MTR-68 : with 68 square holes for elements + 8 for smaller elements.

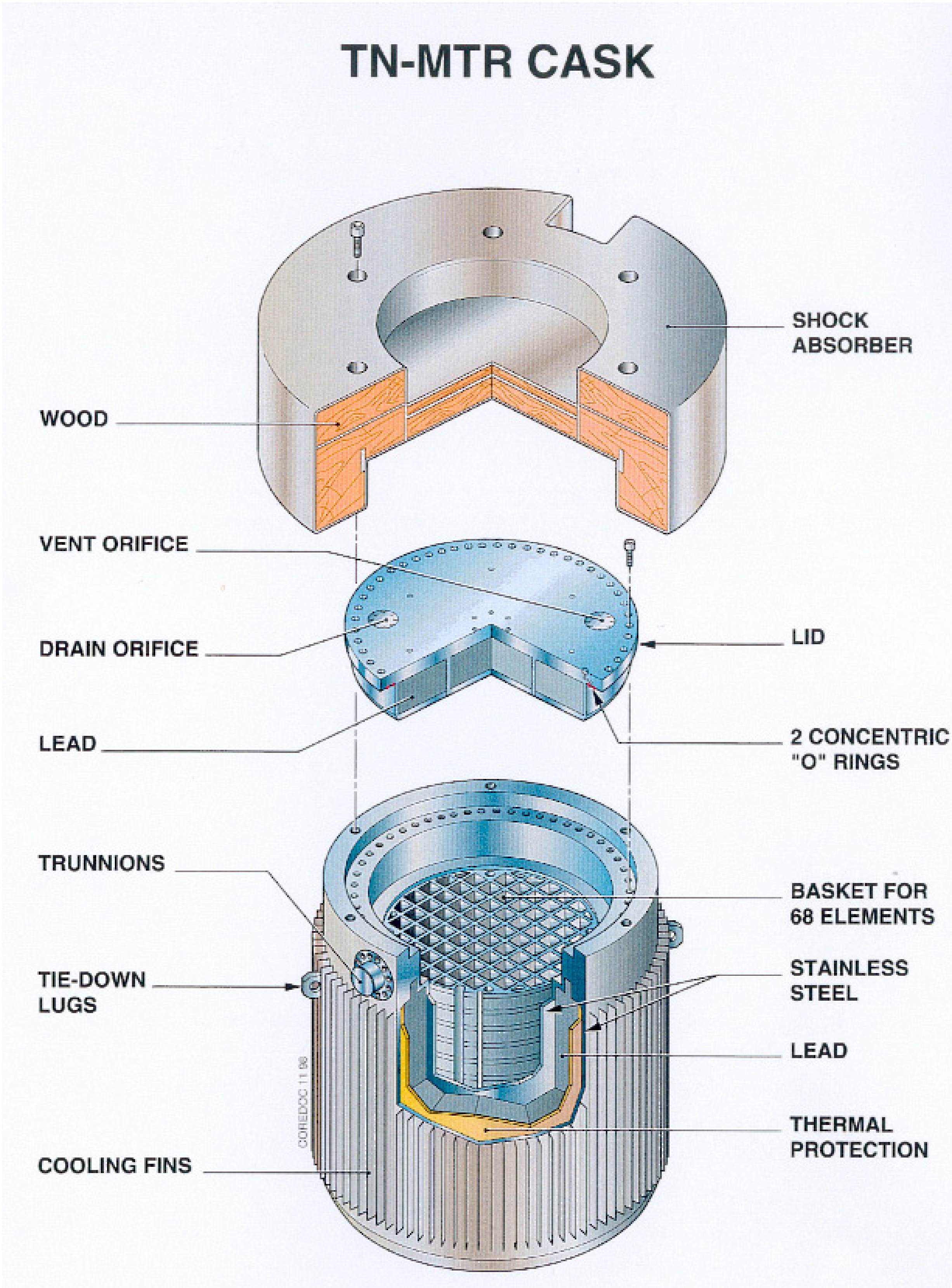
Other baskets can be created to suit new needs.

4 packages belong to French owners (COGEMA LOGISTICS, CEA) and are daily used, particularly in France and Belgium.
Several spot shipments are made in other parts of the world : European countries, the USA, Australia.

The TN-MTR concept enables either dry or easy wet loading and unloading on the sites.
A transfer system can be used in order to facilitate the operations.

The most recent international operations took place in July 2002, and the wet loading of the fuel took only one hour at Risö, Denmark. The delivery at Savannah River was completed to the great satisfaction of the US DOE.

A renewed agreement has just been obtained in France and Belgium, and is in progress in Germany, Denmark, Australia and the USA.


TN-MTR CASK
SHOCK ABSORBER
WOOD
VENT ORIFICE
LID
DRAIN ORIFICE
LEAD
2 CONCENTRIC "O" RINGS
TRUNNIONS
BASKET FOR 68 ELEMENTS
TIE-DOWN LUGS
STAINLESS STEEL
LEAD
THERMAL PROTECTION
COOLING FINS

The **TN-106** is a brand new B (U) F package, meeting AIEA TS R1 regulations, and used for transport of irradiated fuel rods and pins in replacement of the old TN-6 family :

- irradiated fuel rods and pins with uranium oxide enriched at 10% maximum,
- irradiated fuel rods and pins with plutonium oxide or MOX with 12.5% Pu maximum,
- fuel rods and pins from Fast Breeder Reactors with 45% Pu maximum,
- non fissile solid radioactive materials,
- fuel elements with solid metallic uranium mixed to other metals (MTR, Triga, UNGG).

It enables both dry or wet loading and unloading, either in vertical or horizontal position, in order to meet the needs or requirements of Research Reactors or Laboratories, worldwide.

There is something exclusive, which makes the TN-106 a very original package : its design is based on a modular concept, allowing manufacturing of a series of packages with various useful cavity length from 1,000 to 3,200 mm, in accordance with the Research Reactor or Laboratory interface, needs or requirements.

A variety of internal arrangements may be designed for the TN-106 packaging, such as baskets, racks, capsules, etc. Specific internal arrangements can permit an increase of allowable fissile mass.

The TN-106 has received a 5 years agreement from French Authorities, for shipments by road, rail and sea. It is the first time that a license authorises variable length of cavity.
Validations of this agreement are presently under way in European countries and the US.

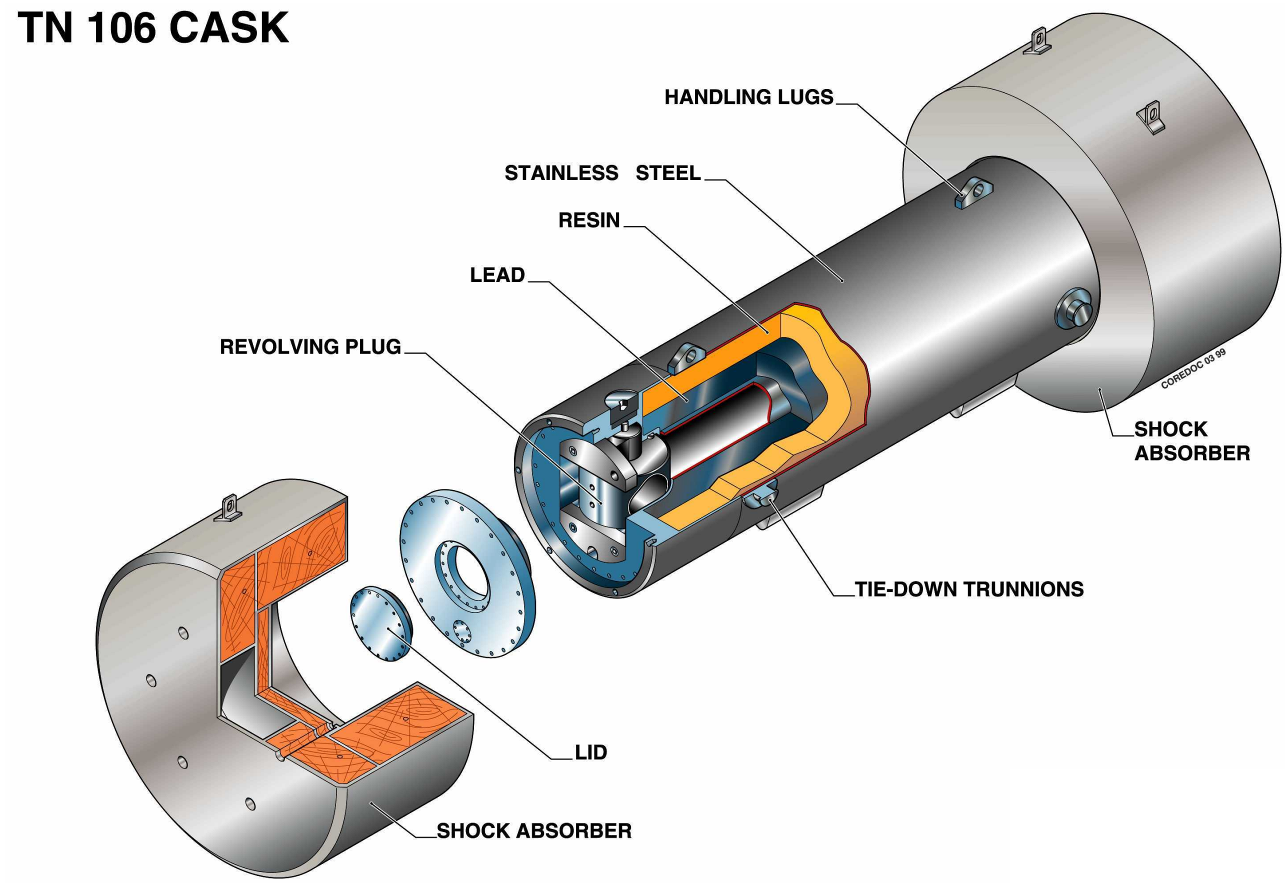
For transport purpose, the TN-106 is tied-down by its 4 trunnions on a transport chassis, which can be loaded into an ISO container. It could also be covered by a tarpaulin.
The associated equipments consist of the transport chassis, the handling lifting beam, an IP2 box containing some tools, and the transport ISO container.
2 Handling lugs fixed onto the package enable also the handling of the package on its chassis.
2 shock absorbers are fixed on the package in transport configuration.

The outer dimensions of the package are :
Overall diameter : 1,458 mm with the shock absorbers,
958 mm including the trunnions, without the shock absorber,
820 mm excluding the trunnions, without the shock absorbers.
The overall length is 1,778 to 3,978 mm without the shock absorbers, and 2,424 to 4,614 mm with the shock absorbers.

As for the internal characteristics, the internal diameter is : 203 mm, and the useful cavity length : 1,000 to 3,200 mm.

The empty package weights from 5.8 to 12.4 tons without the shock absorbers.
The 2 shock absorbers weigh each 0.6 ton, and the overall loaded package with the 2 shock absorbers weigh from 7.2 up to 14.4 tons, depending on the length.

COGEMA LOGISTICS owns presently one TN-106.
The first operational shipment will occur in October in France.



The **RD-26** is a stainless steel type B (U) package, which can be used for multipurpose shipments of various materials, such as :

- alpha contaminated technological wastes put into 118 liters drums (maximum 100 kg),
- UO2 powder, pellets, or part of fuel rods put into specific drums (maximum 70 kg),
- liquid wastes, organic effluents and aqueous solutions in plastic bottles (maximum 150 kg).

The package concept presents one single containment barrier on the lid and orifice plug.
A venting system can be proposed as an option.

The outer dimensions are : 1,145 mm height, and diameter 860 mm.
The inner dimensions of the cavity are : 780 mm height, and diameter 513 mm.
The mass of the empty package is 460 kg.
The filled package can weigh up to 530 to 610 kg maximum, depending on the contents.

The RD-26 can be handled on any site with classical means, such as forklifts, cranes and slings.
Up to 12 packages can be loaded into a 20’ ISO container using a specific rack.

Today, 72 packages are in operation, and more than 30 shipments are performed every year.

The **TN-CIEL** is an innovative concept of mobile tank vehicle type IP2, intended for road transportation of waste radioactive and potentially corrosive liquids :

- liquid effluents,
- concentrates of boric acid (H3BO3) with soda (NaOH) and phosphate,
- CO60 nuclides.

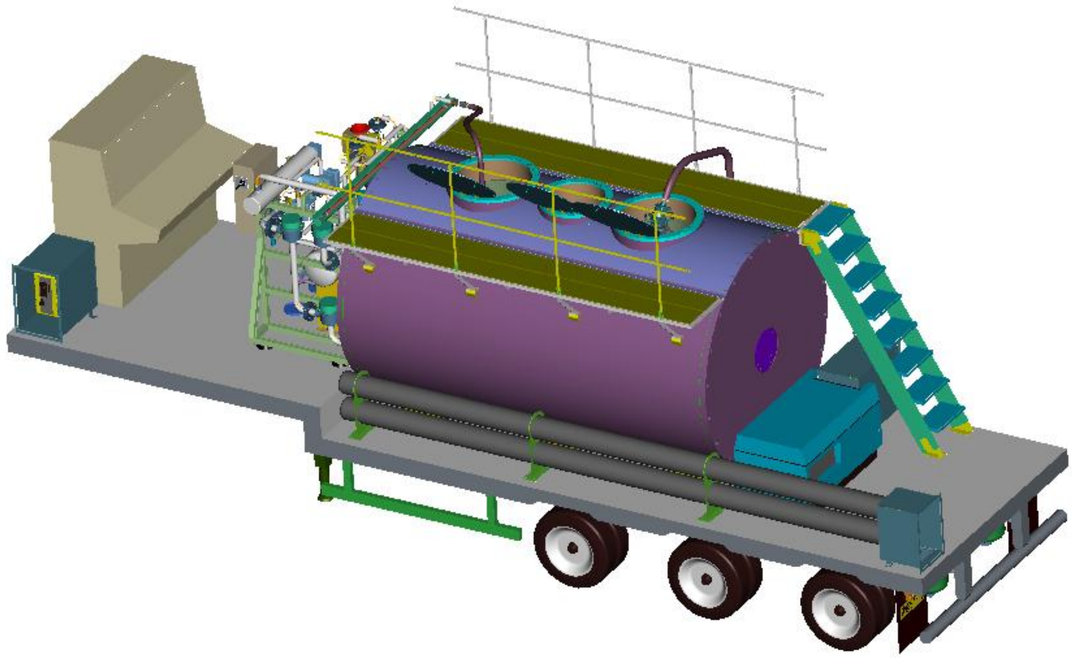
The tank is licensed LSA-II with respect to the IAEA recommendations, and, in Europe, with respect to the ADR road transport regulations for class 7 (radioactive materials), but also for the class 8 (corrosive materials).

The particularity of the liquid wastes is that it crystallises at ambient temperatures.
Therefore it must be transported at a minimum of 60°C. The TN-CIEL tank makes it possible by heating the cavity of the tank at a temperature regulated between 60 and 70 ° C by electrical resistance. Moreover the TN-CIEL tank is equipped with an agitator in order to preclude precipitation in some colder zones.
A pump/compressor that can be connected to one of the three manholes allows loading and unloading of the radioactive liquids in the tank from and to any container.

The maximum allowable tank volume is 5 m3 of low specific activity liquids.

The TN-CIEL mobile tank is now used on a daily basis for transports operations between the 18 EDF NPP to the French incineration facility CENTRACO Marcoule.

The total mass of the vehicle, under 40 tons, enables transport on any type of European road.



Conclusion

There are also several other projects adapted to the specific needs of several international customers. All this new range of packages meets the latest requirements of the regulations or IAEA recommendations. Far more than the former generation, this new family enables multipurpose shipments, of a multiplicity of materials, adapted to a maximum of international sites, avoiding many problems of agreements and validations of specific contents.

Transport of Radioactive Materials on CEA Sites – A Major Challenge for the 2000s : How to Comply with the Safety Regulations and the Control Procedures defined by the French Regulatory Authority

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Abstract

Transports of radioactive materials on nuclear sites are different from transports on public roads because the national or international regulations in force are not strictly applicable[1]. Nevertheless, in France, each operator has set up internal rules applicable for these specific on site transports. These rules have been approved by the relevant competent authority.

The present paper intends**, in a first part**, to summarize the CEA internal transport rules (ITR) and the methodology which has been followed when setting up these internal transport rules. The associated control procedures defined by the competent authority will also be presented. Comparison with the current practice in other countries would be useful.

Beside the strict application of these internal rules when designing **new on site transportation casks**, CEA has to manage a serial of **existing packages** which have been built in the sixteen or seventeen's and whose demonstration of fully compliance with these internal transport rules is very difficult to achieve.

So, for this special purpose, the safety assessment requires a different approach, taking into account the frequency of transports, the possibly of adding compensatory operational measures, local reinforcements of the packages and a serial of other considerations. The methodology followed by the CEA to achieve the safety review for these existing transport packages will be presented in **a second part** of this paper.

Finally, and as a consequence of the previous considerations, an important **program of renewal** of the internal inventory of transportation casks, induced by the need to fully comply with this these ITR has been initiated by the CEA. The philosophy governing this program is presented in the **third part** of the paper, and additional features will be proposed as conclusion.

1 Methodology used to set up CEA internal transport rules

1.1 Basis of the ITR

The ITR (Internal Transport Rules) take into account, on one side, the characteristics of the existing inventory of transportation casks with the associated experience feedback and on an other side, the national and international regulations in force, namely the ADR[2] rules.

Additionally, it has been set as a safety objective and then established, that on site transport operations shall not lead to higher risk than radioactive transports achieved on public roads. The evaluation is made taking into account the specific conditions of transport on site (possibly

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[1] The regulations on the transport of radioactive materials are drawn up by the International Atomic Energy Agency in Vienna and transposed for each mode of transport into the national legislation of each country via the regulations adopted by the international modal organisations (ADR/RID, IMO, …).

[2] ADR: European **A**greement concerning the International carriage of **D**angerous goods by **R**oad.

of rapid intervention after an accident/or an incident, level of radiological consequences in the event of an accident, ….).

So, for example, it has been considered that the design requirements and the test procedures aiming to demonstrate the ability to withstand normal as well as routine conditions of transport on site are quite the same as for public road transports; only the tests required to verify the behaviour of the packaging to withstand accident condition of transport are different and less severe, according to the characteristics of the sites and the specific circulation rules.

The methodology is also based on the different doses to which the operators involved in a transport are exposed in the event of an accident during an on site transport (driver, assistance people, workers staying near the way, general public, …), in analogy with to the "Q-System" methodology usually taken into account for public road accidents [see the definition of the "Q-System" here after].

By comparison with the different models implemented in the "Q-System", only the changes due to the special conditions of on site transports such as the severity of the accidents and/or the specific protection measures which could be employed in the event of an accident (personal protective equipments, time of interventions, distance between the location of the accident and the public, etc.) have been taken into account. All the other parameters shall be considered as identical (range of accident scenarios, prediction of radionuclides releases, radiation exposure pathways, etc.).

On the basis of these criteria, it has been demonstrated that the radiological consequences in case of an on site transport accident, involving an amount of radioactive substance of **100 A2**, could be considered as equivalent to the radiological consequences induced by a public road transport accident, involving an amount of radioactive substances of **A2**.

« **Q-System** »: Dosimetric Model on which the international transport regulations are based, and used for the determination of the maximal amount of radioactive substances authorized to be transported on public roads in a type A packaging, either in a dispersible form (A2) or in a non dispersible form (A1).

Under this « Q-System » a series of exposure routes are considered (external exposure due to β and γ radiation, internal doses via inhalation, skin and ingestion doses, submersion doses due to gaseous isotopes) consecutively to an accident where the damaged package has lost all its containment and radiation protection shielding functions.

In the different scenarios considered, the effective dose to a person exposed in the vicinity of the transport package following an accident should not exceed 50 mSv.

For calculation purposes the person is considered to be at a distance of one metre from the damaged package and to remain at this location for 30 minutes.

AM 735 container used to transfer spent fuel elements between reactors and different examination laboratories, within the Saclay Site.

1.2 Content of the internal transport rules, compared to the ADR regulations

Table 1 here below gives the main content of the CEA internal transport rules, compared to the international/national existing regulations. Additional requirements and standardized classification of transport packages are given in Table 2.

Table 1 – Compared ADR (public road transports) and ITR (on site transports) test requirements

	Public road Transport regulations (ADR)	**Internal Transport Rules (ITR)**
Test for demonstrating ability to withstand **normal and routine** conditions of transport	**Water spray test**: Simulation of an exposure to rainfall of approximately 5 cm per hour for 1 hour.	**Water spray test**: Idem ADR
	Free drop test: Dropping of the specimen on a plane rigid target from a high of 0,3 to 1,2 m, depending on the mass of the package.	**Free drop test**: Idem ADR
	Staking test: Application of a compressive load equivalent to 5 times the mass of the package on the 2 opposite side of the specimen.	**Staking test**: Idem ADR
	Penetration test: Dropping of a cylindrical bar of 3,2 cm diameter and a mass of 6 kg, from a high of 1 m on the specimen.	**Penetration test**: Idem ADR
Test for demonstrating ability to withstand **accident conditions** of transport	**Mechanical tests:** **Drop test I**: Dropping of the specimen on a rigid flat target from a high of 9 m. **Drop test II**: Dropping of the specimen on a cylindrical bar (15 cm diameter and 20 cm long) from a high of 1 m. **Drop test III** : Specimen submitted to a dynamic crash test by a drop of a 500 kg mass from a high of 9 m.	**Mechanicals tests:** **Drop test I**: Dropping of the specimen on a rigid flat target from a high of 2,5 m (or speed reduction under 45 km/h). **Drop test II**: Dropping of the specimen on a cylindrical bar (15 cm diameter and 20 cm long) from a high of 1 m. **Drop test III**: Specimen submitted to a dynamic crash test by a drop of a 500 kg mass from a high of 2,5 m.
	Thermal test: Exposure of the specimen for a period of 30 minutes to a fire of 800 °C.	**Thermal test**: Exposure of the specimen for a period of 15 minutes to a fire of 800 °C.

	Water immersion test: Immersion of the specimen for a period of 8 hours to a high of water of 15 m.	**Water immersion test**: Immersion of the specimen for a period of 8 hours to a high of water of 15 m (or demonstration of absence of any water expense).
Test for demonstrating ability to withstand **accident conditions** of transport	**Leak-tight test:** **Loss of radioactive content:** The loss of radioactive content shall not be more than 10^{-6} A2/h.	**Leak-tight test:** **Loss of radioactive content:** The loss of radioactive content shall not be more than 10^{-6} A2/h (for new packages). It could be of 10^{-4} A2/h for existing packages, if compensatory measures are taken, such as improvement of radiological controls during transport.

1.3 Control procedures defined by the competent authority

In the line of the control procedures applicable for the public road radioactive transports, the French Regulatory Authority has set up the following procedures for controlling the safety of the on site transports:

- Packages involving fissile material or an amount of material higher than 100 A2 require a formal approval from the competent authority (like as for national or international transports).

- Packages involving a quantity transported lower than 100 A2 or consisting of non-fissile material require a formal approval from the Director of the concerned Nuclear Centre.

Concerning the operational aspects of the on site transports, the competent authority proceed to periodic inspections to verify if the other usual transport requirements are fulfilled (maintenance, radiological control, leakage tests, quality assurance programs, organization and management systems, …).

Table 2 – Different type of packages

The international regulation distinguishes different types of radioactive material transport packages:

- **Excepted packages**: a very low level of activity is allowed (less than 10^{-3} A1 or 10^{-3} A2)
- **Industrial packages**: the radioactivity content consists either of a low specific activity material (called LSA: activity lower than 2.10^{-3} A1/g or 10^{-3} A2/g or of a surface contaminated object.
- **Type A packages**: shall not contain activities higher than A2 (dispersible form) or A1 (non dispersible form).
- **Type B packages**: the content is higher than A1 or A2 (in accordance with the values defined in the certificate of approval).
- **Type C packages** (air transport): the activities are higher than 3000 A1 or 3000 A2.
- **Fissile packages**: the content is fissile.

RD 26 container used to transfer irradiated waste drums, contaminated with Pu. within the Cadarache Site

2 Safety assessment principle for existing packages

2.1 General

The methodology is based on the usual safety analysis method, taking into account the possibly of alternative solutions, to comply with the requirements specified in the ITR (the same methodology is used for example when achieving a safety analysis of operating nuclear installations). This method consists in examining different options, in order to select the optimised solution resulting from the review of the following features:

- θ Feasibility of the reinforcements or modifications, which include, namely, the examination of the compliance with:
  - the interfaces of the existing nuclear installations (dimensions of the rooms to be crossed and maximal loads allowed within the installations, …),
  - the overall dimensions of the existing transfer systems within the installations.
- θ Associated costs, compared to the potential benefits, in terms of risk control;
- θ Wherever the safety requirements could not be met, compensatory solutions, aiming at improving the following parameters:
  - reduction of the risk (source term limitation, for example).

- addition of operational procedures such as the reinforcement of the control procedures (leakage tests, radiological measurements), the reinforcement of the fastening systems, etc.
- installation of temporary overall containers order to improve the containment or the radiation protection shielding functions.
- reduction of the speed during the transport in order to reduce the risk of crashes.
- doubling of the transport by a specific fire fighter escort or other intervention means.
- selection of special itinerary, with appropriate marks.
- temporary interruption of the normal traffic on the on site roads.

The aim of this methodology is to carry out a safety analysis identifying the potential hazards (risk and consequences) in the different transport modes: normal operation, routine operation, incidents and accidental situations. Experience feedback shall also be taken into account. The objective of this study is to demonstrate that all the corrective measures, which are of technical type as well as of management type, will be sufficient to control any hazard, within the acceptable limits, with regard to the existing regulations.

2.2 Strategy followed to comply with the existing regulations

As a consequence to the previous considerations, CEA has decided to adopt the following strategy to demonstrate the compliance with these new formal internal transport rules:

θ For the part of the inventory of transportation casks whose compliance with the ITR can be demonstrated by design, safety analysis based mainly on the prevention aspects, will be provided to the competent authority to obtain the periodic certificates of approval.

θ In the other cases, approaches similar to "periodic safety review for existing nuclear installations" will be submitted to the competent authority in order to obtain special arrangements[3]. This methodology may take into account, the estimated lifetime of the package, the nature of the material to be transported, the frequency of the transports, the eventual reinforcements of the package as well as the additional operational measures.

3 Program of renewal of the internal inventory of transportation cask

In addition to this approach, CEA has established a complete inventory of the state of its internal transportation casks, with regard to these new safety regulations criteria. This inventory has lead to a classification into three categories of packages, defined as follows:

- **Category A:** Packages whose fully compliance to internal transport rules can be demonstrated in a first analyse or for which the performance requirements defined in the ITR can be met by means of minor reinforcements or operational correctives measures.

- **Category B:** Packages requiring appreciable modifications or major compensatory measures to meet the performances requirements defined in the ITR.

  The renewal of the corresponding packaging will be progressively undertaken (period covering the forgoing 15 years). About 20 packages are concerned.

[3] Special arrangement shall mean those provisions, approved by the competent authority, under which consignments which do not satisfy all the applicable requirements of the regulations in force, may be transported.

- **Category C:** Packages which do not comply with ITR requirements. Studies for renewal of these packages have still be started. About 12 packages are concerned. The objective is to achieve the complete renewal of the corresponding packages before end of 2006.

4 Conclusion

In order to cope with this situation, CEA has to initiate a ambitious program of renewal of internal transportation packages. This task appears long and difficult since its deals with technical aspects, financials aspects, compliance with research program, involvement of numerous external partners, etc.

Therefore CEA must define needs and priorities to carry out successfully this challenge.

One of the orientation for the future could be the development of multi-purposes containers instead of single use container, the standardization of the transfer systems installed on the plants, etc. Comparison with other practices could be undertaken as well.