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WORLD NUCLEAR TRANSPORT INSTITUTE

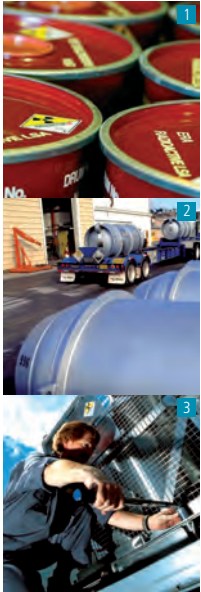
FACT SHEET

# Package Types used for Transporting Radioactive Materials

Dedicated to the safe, efficient and reliable transport of radioactive materials



# Package Types used for Transporting Radioactive Materials



## Introduction

The International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material set the recommended regulatory standards for international transport activities. The basic concept is that safety is vested principally in the package which has to provide shielding to protect workers, the public and the environment against the effects of radiation, to prevent an unwanted chain reaction, to prevent damage caused by heat and also to provide protection against dispersion of the contents. All this has to be achieved under normal conditions and also accident conditions of transport for the more highly radioactive materials. In addition, it is important to reduce radiation doses to workers and the public as far as reasonably achievable by adopting best practice at the operating level.

The Regulations provide for five different types of package:

- Excepted;
- Type A;
- Type C.
- Industrial;
- Type B;

This classification relates to the activity and the physical form of the radioactive material contained in the package. The IAEA also sets performance standards - design requirements and test procedures - for each package type. This graded approach to packaging whereby the package integrity is related to the potential hazard is important for efficient commercial transport operations. It also takes into account the different conditions of transport characterised by the IAEA as follows:

- conditions likely to be encountered in routine transport;
- normal conditions of transport (minor mishaps);
- accident conditions.

There are general design requirements which apply to all packages to ensure that they can be handled safely and easily, secured properly and are able to withstand the effects of any acceleration and vibration.



## Exempted packages

Exempted packages are packages in which the allowed radioactive content is restricted to such low levels that the potential hazards are insignificant and therefore no testing is required with regard to containment or shielding integrity.

A common example of an exempted package is the postal package used to carry radiopharmaceuticals for medical purposes.



## Industrial packages

Industrial packages are used to transport two types of material:

- material having low activity per unit mass (known as Low Specific Activity or LSA material). Items classified as LSA material include hospital waste;
- non-radioactive objects having low levels of surface contamination (known as Surface Contaminated Objects or SCO). Fuel cycle machinery or parts of nuclear reactors, whose surfaces have been contaminated by coolant or process water, are considered as SCO.



Both types of material are inherently safe, either because the contained activity is very low, or because the material is not in a form easily dispersible.

Industrial Packages (IP) are sub-divided into three categories designated as IP-1, IP-2 and IP-3, which differ regarding the degree to which they are required to withstand routine and normal conditions of transport (see Table 1). The required tests simulate normal transport conditions such as a fall from a vehicle, exposure to rain, or being struck by a sharp object, or having other cargo stacked on top.

Packages used in industry such as steel drums or bins could meet these various requirements, but purpose-designed packages are also frequently used. The choice depends on the characteristics of the material.

Some typical materials transported in industrial packages are low-level and intermediate-level radioactive waste, or ores containing naturally occurring radionuclides (e.g. uranium or thorium) and concentrates of such ores.

Table 1: Industrial Package Requirements

Criteria	IP-1	IP-2	IP-3
Design requirements	<ul style="list-style-type: none"> <li>■ General requirements for all packages</li> <li>■ Additional pressure and temperature requirements if transported by air</li> </ul>	<ul style="list-style-type: none"> <li>■ General requirements for all packages</li> <li>■ Additional pressure and temperature requirements if transported by air</li> </ul>	<ul style="list-style-type: none"> <li>■ General requirements for all packages</li> <li>■ Additional pressure and temperature requirements if transported by air</li> <li>■ Type A additional requirements</li> </ul>
Test requirements - normal transport conditions		<ul style="list-style-type: none"> <li>■ Free drop (from 0.3 to 1.2 metres, depending on the mass of the package)</li> <li>■ Stacking or compression</li> </ul>	<p>Each of the following tests must be preceded by a water spray test:</p> <ul style="list-style-type: none"> <li>■ free drop (from 0.3 to 1.2 metres, depending on the mass of the package)</li> <li>■ stacking or compression</li> <li>■ penetration (6kg bar dropped from 1 metre)</li> </ul>

## Type A packages

Type A packages are used for the transport of relatively small, but significant, quantities of radioactive material. Since it is assumed that this type of package theoretically could be damaged in a severe accident and that a portion of their contents may be released, the amount of radionuclides they can contain is limited by the IAEA Regulations. In the event of a release, these limits ensure that the risks from external radiation or contamination are very low.

Type A packages are required to maintain their integrity during normal transport conditions and therefore are subjected to tests simulating these conditions (see Table 2).

Type A packages are used to transport radioisotopes for medical diagnosis or teletherapy, technetium, generators used to assist in the diagnosis of certain cancers, and also for some nuclear fuel cycle materials.

Table 2: Type A Package Requirements

Criteria	Requirements
Design requirements	<ul style="list-style-type: none"><li>■ General requirements for all packages</li><li>■ Additional pressure and temperature requirements if transported by air</li><li>■ Type A additional requirements (seals, tie-downs, temperature, containment, reduced pressure, valves)</li></ul>
Test requirements - normal transport conditions	Each of the following tests must be preceded by a water spray test: <ul style="list-style-type: none"><li>■ free drop (from 0.3 – 1.2 metres, depending on the mass of the package)</li><li>■ stacking or compression</li><li>■ penetration (6kg bar dropped from 1 metre)</li></ul>

## Type B packages

Type B packages are required for the transport of highly radioactive material. These packages must withstand the same normal transport conditions as Type A packages, but because their contents exceed the Type A limits, it is necessary to specify additional resistance to release of radiation or radioactive material due to accidental damage.

The concept is that this type of package must be capable of withstanding expected accident conditions, without breach of its containment or an increase in radiation to a level which would endanger the general public and those involved in rescue or clean-up

operations. The adequacy of the package to this requirement is demonstrated by stringent accident conditions testing (see Table 3).

Type B packages are used to transport material as different as unencapsulated radioisotopes for medical and research uses, spent nuclear fuel, and vitrified high-level waste.

Table 3: Type B Package Requirements

Criteria	Requirements
Design requirements	<ul style="list-style-type: none"> <li>■ General requirements for all packages</li> <li>■ Additional pressure and temperature requirements if transported by air</li> <li>■ Type A additional requirements</li> <li>■ Type B additional requirements (internal heat generation and maximum surface temperature)</li> </ul>
Test requirements - normal transport conditions	<p>Each of the following tests must be preceded by a water spray test:</p> <ul style="list-style-type: none"> <li>■ free drop (from 0.3 to 1.2 metres, depending on the mass of the package)</li> <li>■ stacking or compression</li> <li>■ penetration 6kg bar dropped from 1 metre</li> </ul>
Test requirements - accidental transport conditions	<p>Cumulative effects of:</p> <ul style="list-style-type: none"> <li>■ free drop from 9 metres or dynamic crush test (drop of a 500kg mass from 9 metres onto a specimen)</li> <li>■ puncture test</li> <li>■ thermal test (fire of 800°C intensity for 30 minutes)</li> <li>■ immersion (15 metres for 8 hours)</li> </ul> <p>Enhanced immersion test for packages carrying a large amount of radioactive material:</p> <ul style="list-style-type: none"> <li>■ 200 metres for 1 hour</li> </ul>

## Type C packages

The 1996 Edition of the IAEA Transport Regulations introduced a requirement for a more robustly designed package – the Type C Package – to transport the more highly radioactive material by air. Type C packages must satisfy all the additional requirements of Type A packages and most of the additional requirements of Type B packages.

Type C packages are submitted to a series of tests to prove their ability to withstand transport incidents and accidents (see Table 4). This type of package has not yet been developed.



Table 4: Type C Package Requirements

Criteria	Requirements
Design requirements	<ul style="list-style-type: none"> <li>■ General requirements for all packages</li> <li>■ Additional pressure and temperature requirements if transported by air</li> <li>■ Type A additional requirements</li> <li>■ Type B additional requirements (internal heat generation and maximum surface temperature)</li> </ul>
Test requirements - normal transport conditions	<p>Each of the following tests must be preceded by a water spray test:</p> <ul style="list-style-type: none"> <li>■ free drop (from 0.3 to 1.2 metres, depending on the mass of the package)</li> <li>■ stacking or compression</li> <li>■ penetration 6kg bar dropped from 1 metre</li> </ul>
Test requirements - accidental transport conditions	<p>Test sequence on one specimen in the following order:</p> <ul style="list-style-type: none"> <li>■ free drop from 9 metres</li> <li>■ dynamic crush test (drop of a 500kg mass from 9 metres onto a specimen)</li> <li>■ puncture test</li> <li>■ enhanced thermal test (fire of 800°C intensity for 60 minutes)</li> </ul> <p>A separate specimen may be used for the following test:</p> <ul style="list-style-type: none"> <li>■ impact test (not less than 90 metres per second)</li> </ul>

## Packages for fissile material

Nuclear fuel cycle materials containing enriched uranium or plutonium are fissile, i.e. they can support a chain reaction. Such unwanted chain reactions are prevented during normal and accidental transport conditions by

the design of the package, the arrangement of the fissile material in it and also the configuration of multiple packages.



## Packages for uranium hexafluoride

The IAEA Regulations include requirements for packages containing uranium hexafluoride (Hex) which are specific to this material.

These packages must meet the following test requirements:

- withstand a pressure test of at least 1.4MPa;
- withstand a free drop test – the drop height depending on the mass;
- withstand a thermal test at a temperature of 800°C for 30 minutes.

## Photographs

- 1 Drums of uranium ore concentrate (Industrial package)
- 2 48" cylinders for transporting Hex
- 3 Cobalt-60 cask (Type B package)
- 4 Spent nuclear fuel cask (Type B package)
- 5 MOX fuel cask (Type B package)
- 6 Package used to transport empty spent fuel baskets (Type A package)

WNTI

WORLD NUCLEAR TRANSPORT INSTITUTE

Remo House  
310-312 Regent Street  
London W1B 3AX  
United Kingdom  
Tel: +44 (0)20 7580 1144  
Fax: +44 (0)20 7580 5365  
Web: [www.wnti.co.uk](http://www.wnti.co.uk)  
Email: [wnti@wnti.co.uk](mailto:wnti@wnti.co.uk)

