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Transport of Radioisotopes

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TRANSPORT OF RADIOISOTOPES

This document contains the transparencies shown at the lecture on " Transport of radioisotopes " held at the International Centre for Theoretical Physics - Trieste - during the period 5-23 September 1994.

It takes into account only the main provisions required by the " Regulations for the Safe Transport of Radioactive Materials" - Safety Series n° 6 - 1985 Edition (As amended 1990) to transport radioisotopes used in medicine, with no references to industrial radioactive sources and fissile material.

Safety Series n° 6 is the fundamental standard used all over the world to establish cogent international and national regulations for the transport of radioactive material by all modes on land, water and air.

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safety series
No. 6

IAEA SAFETY STANDARDS

Regulations
for the Safe Transport
of Radioactive Material
1985 Edition

(As Amended 1990)

Transport Regulations shall apply

to the transport of any material having a specific activity greater than 70 kBq/kg (radioactive material)

Transport Regulations do not apply

to human beings who have been implanted with radioisotopic cardiac pacemakers or other devices, or who have been treated with radiopharmaceuticals.

SAFETY IN THE TRANSPORT

Packaging + Content
Radiation level
Non-fixed contamination
Label
Quality assurance programme
Approval of shipment
Shipment under special arrangements
Accident provision

PACKAGE

Package shall mean the packaging with its radioactive contents as presented for transport.

Conditions of transport	Classification
conditions likely to be encountered in routine transport (in incident free conditions)	Excepted Industrial Type 1 (IP-1)
normal conditions of transport (minor mishaps)	Industrial Type 2 (IP-2) Industrial Type 3 (IP-3) Type A
accident conditions of transport	Type B

SPECIAL FORM RADIOACTIVE MATERIAL

Special form radioactive material shall mean either an indispersible solid radioactive material or a sealed capsule containing radioactive material.

(Certificate)

A1 and A2

A1	the maximum activity of special form radioactive material permitted in a Type A package.
A2	the maximum activity of radioactive material, other than special form radioactive material, permitted in a Type A package.

A1 and A2 values

Radionuclide	A1 TBq	A2 TBq
^{241}Am	2	0.02
^{60}Co	0.4	0.4
^{137}Cs	2	0.5
^{125}I	20	2
^{131}I	3	0.5
^{192}Ir	1	0.5
^{85}Kr	20	10
^{147}Pm	40	0.9
^{239}Pu	2	0.0002
^{241}Pu	40	0.01
^{90}Sr	0.2	0.1
U natural	unlimited	unlimited

LOW SPECIFIC ACTIVITY MATERIAL

LSA-I	**-Radioactive material with unlimited A2 (not fissile)**
LSA-II	**-Water with tritium concentration up to 0.8 TBq/L** **-Material with estimated average specific activity less than 10^{-4} A2/g for solids and gases, and 10^{-5} A2/g for liquids.**
LSA-III	**-The radioactive material is distributed throughout a solid** **-Leaching in water for 7 days less than 0.1 A2** **-Estimated average specific activity less than 2×10^{-3} A2/g.**

TRANSPORT INDEX

The transport index (TI) shall be the maximum radiation level (mSv/h) at a distance of 1 m from the external surfaces of the package, overpack and freight container multiplied by 100.

It is used to establish:

- **control over radiation exposure**
- **contents limits on certain packages, overpacks and freight containers**
- **categories for labelling**
- **spacing requirements during storage in transit**
- **the number of packages allowed in a freight container or aboard a conveyance.**

SURFACE CONTAMINATED OBJECT

SCO-I	**- non-fixed contamination on the accessible surface less than 4 (0.4) Bq/cm²** **-fixed contamination on the accessible surface less than 40 (4) kBq/cm²** **- contamination on the inaccessible surface less than 40 (4) kBq/cm²**
SCO-II	**-non-fixed contamination on the accessible surface less than 400 (40) Bq/cm²** **- fixed contamination on the accessible surface less than 800 (80) kBq/cm²** **- contamination on the inaccessible surface less than 800 (80) kBq/cm²**

SPECIAL FORM RADIOACTIVE MATERIAL

one dimension not less than 5 mm
impact test from a height of 9 m
percussion test (1.4 kg from 1 m)
bending test
heat test to 800°C for 10 min
leaching less than 2 kBq
competent authority certificate

EXCEPTED PACKAGE

-designed for an easy and safe handling
-lifting attachments designed with a safety factor
-outer attachments removable or not used for lifting
-external surfaces can be easily decontaminated
-prevent the retention of water
-capable to withstand acceleration and vibration

TYPE A PACKAGE

-excepted package requirements
-water spray test
-1.2-0.3 m free drop test for solids 9 m free drop test for liquid and gas
-stacking test
-1 m penetration test with a bar of 6 kg - 3.2 cm for solids 1.7 m for liquid and gas

ACTIVITY LIMITS FOR EXCEPTED PACKAGES

Physical state of contents	Instruments and articles		Materials
	Item limits	Package limits	Package limits
Solids:			
special form	10^{-2} A1	A1	10^{-2} A1
other forms	10^{-2} A2	A2	10^{-2} A2
Liquids:	10^{-3} A1	10^{-1} A1	10^{-4} A2
Gases:			
tritium	2×10^{-2} A1	2×10^{-1} A1	2×10^{-2} A1
special form	10^{-3} A1	10^{-2} A1	10^{-3} A1
other forms	10^{-3} A2	10^{-2} A2	10^{-3} A2

TYPE B PACKAGE

-Type A requirements
Mechanical test -9 m free drop test -1 m free drop test onto a bar of 15 cm in diameter
-Thermal test 800 °C for a period of 30 min
-Water immersion test under a head of water of 15 m for 8 hours
Competent authority certificate

REQUIREMENTS AND CONTROLS FOR EXCEPTED PACKAGES

The radiation level at any point on the external surface shall not exceed 5 μSv/h.
Instrument or other manufactured article **-The radiation level at 10 cm from any point on the external surface of any unpackaged instrument or article shall be not greater than 0.1 mSv/h** **-Each instrument or article (except radioluminescent time-pieces or devices) shall bear the marking "Radioactive".**
Radioactive material **-The package shall bear the marking "Radioactive" on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.**

LIMITS OF NON-FIXED CONTAMINATION ON SURFACES

	Contaminant	
External surfaces of:	**Applicable limit of beta and gamma emitters and low toxicity alpha emitters** **Bq/cm²**	**Applicable limit of all other alpha emitters** **Bq/cm²**
excepted packages	**0.4**	**0.04**
other than excepted packages	**4**	**0.4**
External and internal surfaces of overpacks, freight containers and conveyances when used for the carriage of:		
loads including excepted packages and/or non-radioactive consignments	**0.4**	**0.04**
loads consisting only of radioactive material in packages other than excepted packages	**4**	**0.4**

INDUSTRIAL PACKAGE REQUIREMENTS FOR LSA MATERIAL AND SCO

Contents	Exclusive use	Not under exclusive use
LSA-I		
Solid	**IP-1**	**IP-1**
Liquid	**IP-1**	**IP-2**
LSA-II		
Solid	**IP-2**	**IP-2**
Liquid	**IP-2**	**IP-3**
LSA-III	**IP-2**	**IP-3**
SCO-I	**IP-1**	**IP-1**
SCO-II	**IP-2**	**IP-2**

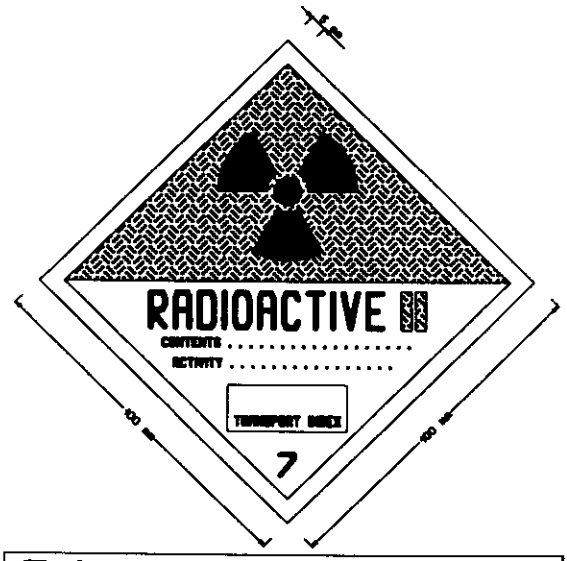
CATEGORIES OF PACKAGES

Conditions		Category
Transport index	**Maximum radiation level at any point on external surface**	
0	**Not more than 0.005 mSv/h**	**I-WHITE**
More than 0 but not more than 1	**More than 0.005 mSv/h but not more than 0.5 mSv/h**	**II-YELLOW**
More than 1 but not more than 10	**More than 0.5 mSv/h but not more than 2 mSv/h**	**III-YELLOW**
More than 10	**More than 2 mSv/h but not more than 10 mSv/h**	**III-YELLOW and also under exclusive use**

Category I-WHITE label

The background colour of the label shall be white, the colour of the trefoil and the printing shall be black, and the colour of the category bar shall be red.

Category II-Yellow label



The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

Category III-Yellow label

The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

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