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Department of Health

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GUIDELINES FOR THE SAFE TRANSPORT OF  
RADIOACTIVE MATERIAL

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Compiled by

TRUG91-1

Directorate Radiation Control

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## CONTENTS

1	INTRODUCTION	1
2	DEFINITIONS	1
3	TYPES OF CONTAINERS	2
3.1	General requirements for all packages	2
3.2	Requirements for excepted packages	2
3.3	Requirements for Type A packages	3
3.4	Requirements for Type B packages	4
4	REQUIREMENTS DURING TRANSPORTATION	5
4.1	Segregation during transport and during storage in transit	5
4.2	Additional requirements relating to rail and road	5
4.3	Additional requirements relating to transport by air	5
4.4	Post	6
4.5	Maximum radiation levels (with exclusive and without exclusive use)	6
4.6	Contamination and decontamination on packages, freight containers, tanks and overpacks	6
5	LABELLING AND DOCUMENTATION	7
5.1	Labelling and marking of packages, freight containers, tanks and overpacks	7
5.2	Placards on vehicles, freight containers and tanks	7
5.3	Transport documents	7
6	CONSIGNOR'S RESPONSIBILITY	8
7	REFERENCES	8

## LIST OF TABLES

TABLE 1	ACTIVITY LIMITS FOR EXCEPTED PACKAGES	3
TABLE 2	CONTAMINATION LIMITS	6
TABLE 3	CATEGORIES OF PACKAGES	7
TABLE 4	ACTIVITY LIMITS	10



## 1 INTRODUCTION

This code provides information concerning the safe transport of radioactive material not related to the nuclear fuel cycle. It is not intended to be comprehensive, but aims to summarise and supplement the IAEA transport regulations. The IAEA regulations, drawn up by the International Atomic Energy Agency, must be adhered to at all times when radioactive material is being transported in South Africa, or internationally. The Department should be consulted if a conveyor has any queries regarding the safe transport of radioactive materials.

Although some of the requirements for the different types of packages are specified in this brochure, conveyors are encouraged to use approved containers wherever possible. Most gauges containing radionuclides incorporate approved transport containers, but if this is not the case, such containers can be obtained from Necsa.

To determine the requirements for the transport of radioactive materials the following questions must be answered sequentially:

- 1 What type of package/container should be used?
- 2 Will it be transported by air, sea, road or rail and what will the requirements be during transport?
- 3 How should the container and vehicle be marked, labelled and placarded?
- 4 What are the consignor's responsibilities?

## 2 DEFINITIONS

*Exclusive use* shall mean the sole use, by a single consignor, of a conveyance or a large freight container 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 directives of the consignor or consignee.

*Freight container* shall mean an article of transport equipment designed to facilitate the carriage of goods, either packaged or unpackaged, by one or more modes of transport without intermediate reloading. It shall be of a permanent enclosed character, rigid and strong enough for repeated use, and must be fitted with devices facilitating its handling, particularly in transfer between conveyances and from one mode of transport to another.

*Radioactive material* means any substance which consists of or contains any radioactive nuclide whether natural or artificial and whose specific activity exceeds 74 Bq/g (0,002 uCi/g) of chemical element and which has a total activity greater than 3,7 kBq (0,1 uCi).

*Special form radioactive material* shall mean either an indispersible solid radioactive material or a sealed capsule containing radioactive material. It shall have at least one dimension not less than 5 mm, and must comply with certain prescribed test requirements (e.g. emersion, heat, impact, percussion and bending tests).

*Transport index (TI)* shall mean a single number assigned to a package which is used to provide control over radiation exposure. It is the maximum radiation level in mRem/hr (uSv/hr divided by 10) at 1 m from the external surface of the package.

*UN number:* is a United Nations number that is allocated to all the different kinds of transported dangerous materials (among which radioactive materials are included). This number is frequently required to be provided on transport documents. A few of the UN numbers are listed below (others may be obtained from IATA's "Dangerous Goods Regulations"):

UN 2910	Radioactive material - excepted packages, instruments, articles, or empty packages.
UN 2974	Radioactive material in special form.
UN 2982	Radioactive material, not otherwise specified.

### 3 TYPES OF CONTAINERS

The three most common types of packages or containers commonly used in South Africa are the "excepted" package, the Type A package, and the Type B package.

#### 3.1 General requirements for all packages

All containers or packages shall comply with the following general requirements:

- (i) The package design shall be such that it can be easily handled, transported and secured during transport.
- (ii) Lifting attachments on packages shall not fail when used in the intended manner. If failure occurs it shall not impair other requirements. Lifting attachments shall either be able to support the package or be removed or rendered incapable during transport.
- (iii) External surfaces shall be free from protruding features for easy decontamination.
- (iv) The outer packaging shall prevent, as far as possible, the retention of water.
- (v) Features added to the package during transport shall not reduce its safety.
- (vi) The package and its closing devices shall not be affected under conditions it would most likely experience during transport.
- (vii) The materials of the package shall be physically and chemically compatible with each other and with the radioactive contents.
- (viii) Valves through which radioactive material can escape shall be protected against unauthorised operation.
- (ix) Other dangerous properties of contents such as explosiveness, flammability, pyrophoricity, chemical toxicity and corrosiveness, shall be taken into account.

#### 3.2 Requirements for excepted packages

- (i) The package must meet the general requirements for all packages stated in section 1.
- (ii) The radiation levels on the external surface of the package shall not exceed 5 uSv/h (0.5 mrem/h).
- (iii) Excepted packages may contain radioactive material which is enclosed in or forms a component part of an instrument and does not exceed the limits specified in columns 2 and 3 in Table 1, provided that:
  - (a) the radiation levels 10 cm from the external surface of the unpacked instrument or article, do not exceed 0.1 mSv/h (10 mRem/h);
  - (b) the instrument or article (except radioluminescent time-pieces or devices) is marked "RADIOACTIVE".
- (iv) Excepted packages may contain radioactive material in forms other than as specified in the previous paragraph, with an activity not exceeding the limits specified in column 4 of Table 1, provided that:
  - (a) the packages retain their contents under conditions likely to be encountered in routine transport;

- (b) the packages bear the marking "RADIOACTIVE" on an **internal surface** in such a manner that a warning of the presence of radioactive material is visible on the opening of the package.

**TABLE 1 ACTIVITY LIMITS FOR EXCEPTED PACKAGES**

Physical state of contents	Instruments and articles		Materials
	Item limits	Package limits	Package limits
Solids:			
Special form	$10^{-2}A_1$	$A_1$	$10^{-3}A_1$
Other forms	$10^{-2}A_2$	$A_2$	$10^{-3}A_2$
Liquids:	$10^{-3}A_2$	$10^{-1}A_2$	$10^{-4}A_2$
Gasses:			
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 forms	$10^{-3}A_2$	$10^{-2}A_2$	$10^{-3}A_2$

### 3.3 Requirements for Type A packages

Radioactive material in quantities which represent a limited radiation risk may be carried in a Type A package, which shall be designed to withstand **normal** conditions of transport. The source containers incorporated in nuclear gauges are often approved Type A containers, so that many gauges can be transported as is. Where this is not the case, the user must provide his own container. Containers which would typically meet A-standards are strong metal tins, or sturdy wooden boxes. Type A containers do not require the specific approval of the Department, but it is the responsibility of the consignor to ensure that he uses a container which would comply with the requirements listed below. If suitable packaging is not readily available, standard Type A containers can be obtained from Necsa.

The attached table (table 4) should be consulted when a decision must be made as to whether radioactive material may be transported in a Type A package or not, as there are limits on the activity which may be transported in such a package. If the radioactive material is in special form, up to an activity of  $A_1$  may be transported in an A Type package, and if the material is not in special form, an activity not exceeding  $A_2$  may be transported in such a package.

Type A packages must comply with the following requirements:

- (i) The package shall meet the general requirements for all packages stated in section 1.
- (ii) The smallest overall external dimension of the Type A package shall not be less than 10 cm.
- (iii) The outside of the Type A package shall incorporate a feature such as a seal, which is not readily breakable and which, while intact, will be evidence that it has not been opened.

- (iv) Tie-down attachments shall under all conditions not impair the ability of the package to meet the requirements of the Department.
- (v) Package design shall take into account temperatures ranging from -40 °C to 70 °C.
- (vi) The package shall include a containment system which cannot be opened unintentionally.
- (vii) If the containment system forms a separate unit of the package, it shall be capable of being securely closed by a positive fastening device which is independent of any other part of the packaging.
- (viii) The containment system shall retain its radioactive contents under a reduction of ambient pressure to 25 kPa.
- (ix) All openings, e.g. exit channels, valves, etc., shall be closed to retain leakage.
- (x) Packages containing liquids shall:
  - a. have absorbent material to absorb twice the volume of the contents if the volume is less than 50 ml;
  - b. shall have primary inner and secondary outer containment components for the retention of the liquid if the volume exceeds 50 ml;
  - c. shall make provision for ullage to accommodate variations in temperature, dynamic effects and filling dynamics.
- (xi) Type A packages should also be able to withstand a number of tests. These tests are well described in the IAEA Safety Series 6 and include a water spray test, a free drop test, a stacking test and a penetration test.
- (xii) If the contents are special form radioactive material, and exceed the  $A_2$  activity limit, Departmental approval of the design for the special form radioactive material is required.
- (xiii) The package shall be so designed that, under normal conditions of transport, it shall prevent loss or dispersal of the radioactive contents, and loss of shielding integrity which would result in more than a 20% increase in the radiation level on any external surface.

### 3.4 Requirements for Type B packages

Where Type A activity limits are exceeded, approved Type B containers/packages (either B(U) or B(M) packages) must be used, unless the Department specifically permits otherwise. A Type B container is a specially designed and approved container, constructed to withstand **both normal and accidental** conditions of transport. The requirements and tests to which these packages are subjected, are much more severe than those for Type A packages. A B(U) container is suitable for international transport and requires only unilateral approval. A B(M) container, because it fails to meet one or more specific design requirements for a B(U) container, requires multilateral approval i.e. it requires the approval of the competent authority in each country through which it is transported.

Typical examples of Type B(U) packages are approved industrial radiography containers (Techops, Gammamat, etc.), source heads of approved teletherapy units, approved transport containers for  $^{60}\text{Co}$  sources for irradiation plants, etc.

The limit on the total activity in a Type B package is as prescribed in the design approval certificate for that package.



## 4 REQUIREMENTS DURING TRANSPORTATION

### 4.1 Segregation during transport and during storage in transit

- (i) Radioactive material shall be segregated sufficiently from transport workers and from members of the public. For the purpose only of calculating segregation distances or dose rates in regularly occupied areas, different limiting values for dose shall be required:
  - (a) For transport workers a dose level of 5 mSv (500 mrem) per year shall be used as the limiting value.
  - (b) For members of the public a dose level of not more than 1 mSv (100 mrem) per year to the critical group shall be used as the limiting value.
- (ii) Radioactive material shall be segregated from undeveloped photographic film so that the radiation exposure of the film is limited to 0,1 mSv (10 mrem) per consignment of such film.
- (iii) Categories II-YELLOW or III-YELLOW packages (see table 3) shall not be carried in compartments occupied by passengers except for exclusively authorised personnel.
- (iv) The number of category II-YELLOW and category III-YELLOW packages, overpacks, tanks and freight containers stored in any one area shall be so limited that the total sum of the transport indices in any individual group of such packages does not exceed 50. Groups of such packages shall be stored so as to maintain a spacing of at least 6 m from other groups of such packages.
- (v) Only articles or documents which are necessary for the use of radioactive material are permitted in the package provided that there is no interaction between them and the packaging or its contents that would reduce the safety of the package. Other items may not be transported in packages.
- (vi) Mixing of packages of different kinds of radioactive material, including fissile material, and mixing of packages with different indexes (TI's) is permitted.
- (vii) Consignments shall be segregated from other dangerous goods.

### 4.2 Additional requirements relating to rail and road

- (i) Vehicles or railroad carriages carrying packages with category I-WHITE, II-YELLOW and III-YELLOW transport labels shall display radiation warning signs. Vehicles carrying excepted packages need not be so marked.
- (ii) No persons other than the driver and assistants shall be permitted in vehicles carrying packages bearing category II-YELLOW or III-YELLOW labels.
- (iii) The radiation level at any normally occupied position shall not exceed 0,02 mSv/h (2 mrem/h) unless the persons occupying such positions are provided with personal monitoring devices.

### 4.3 Additional requirements relating to transport by air

- (i) Type B(M) packages under exclusive use and vented Type B(M) packages which require external cooling shall not be transported on passenger aircraft.
- (ii) Packages having a surface radiation level greater than 2 mSv/h (200 mrem/h) shall not be transported by air except by special arrangement.

### 4.4 Post

No radioactive materials are permitted to be dispatched by post in the RSA.

**4.5 Maximum radiation levels (with exclusive and without exclusive use)**

The radiation levels shall not exceed (except under exclusive use):

- (i) 0.1 mSv/h (10 mrem/h) at 1 m from the external surface of the package.
- (ii) 2 mSv/h (200 mrem/h) on the external surface of the package.

If the package is transported under exclusive use, the radiation levels shall not exceed 10 mSv/h (1000 mrem/h) on the external surface of the package.

The radiation levels may exceed 2 mSv/h (200 mrem/h) on an external surface only under the following circumstances:

- (i) If transported under exclusive use by rail or road provided that:
  - a. the vehicle is equipped with an enclosure to prevent unauthorized access during transport;
  - b. the package or overpack is secured to retain its position within the enclosure during transport;
  - c. there are no loading and unloading operations between the beginning and end of the shipment.
- (ii) If transported by air provided that:
  - a. the package is transported under exclusive use; and
  - b. the transport takes place by special arrangement.
- (iii) If transported by vessel (i.e. by sea) provided that:
  - a. the package is transported under exclusive use; or
  - b. the transport takes place by special arrangement.

**4.6 Contamination and decontamination on packages, freight containers, tanks and overpacks**

- (i) Contamination levels shall be kept as low as reasonably possible and shall not exceed the values specified below:

**TABLE 2 CONTAMINATION LIMITS**

Beta & gamma emitters and low toxicity alpha emitters	Alpha emitters: other than those of low toxicity
4 Bq/cm <sup>2</sup> (10 <sup>-4</sup> μCi/cm <sup>2</sup> )	0.4 Bq/cm <sup>2</sup> (10 <sup>-5</sup> μCi/cm <sup>2</sup> )

- (ii) Conveyances, equipment or parts thereof which have become contaminated shall be decontaminated as soon as possible and in any case before re-use.
- (iii) Packages, used for the transport of radioactive material shall not be used for the storage or transport of other goods.

## 5 LABELLING AND DOCUMENTATION

### 5.1 Labelling and marking of packages, freight containers, tanks and overpacks

**TABLE 3 CATEGORIES OF PACKAGES**

Transport index (TI)	Maximum radiation level (H) at any point on the external surface	Category
0	$5 \mu\text{Sv/h} < H$	I-WHITE
$0 < \text{TI} < 1$	$5 \mu\text{Sv/h} < H < 0.5 \text{ mSv/h}$	II-YELLOW
$1 < \text{TI} < 10$	$0.5 \text{ mSv/h} < H < 2 \text{ mSv/h}$	III-YELLOW
$\text{TI} < 10$	$2 \text{ mSv/h} < H < 10 \text{ mSv/h}$	III-YELLOW and exclusive use

- (i) Completed WHITE or YELLOW labels with the contents described (with the name of the radionuclide, or for mixtures, the names of the most restrictive nuclides) shall be affixed externally to two opposite sides of packages and to all four sides of tanks.
- (ii) Each label shall be marked with the maximum activity of the radioactive contents during transport.
- (iii) Each YELLOW label shall be marked with the TI for that package.
- (iv) Packages with a gross mass exceeding 50 kg shall be legibly and durably marked with their permissible gross mass on the outside.
- (v) Packages shall be legibly and durably marked on the outside with the word "TYPE A" or "TYPE B(U)", or whatever is applicable.
- (vi) Packages containing materials having additional dangerous properties (e.g. uranium hexafluoride) shall also be labelled as required by other relevant transport regulations.

### 5.2 Placards on vehicles, freight containers and tanks

- (i) Placards shall be affixed in a vertical orientation:
  - (a) to the two external walls of a rail vehicle;
  - (b) to the two external lateral walls and the external rear wall of a road vehicle; and
  - (c) to the two external side walls and the two external end walls of a freight container or tank; alternatively, enlarged labels may be used.
- (ii) The appropriate UN Number shall be displayed on all four sides of the freight container.
- (iii) Any placards that do not relate to the contents shall be removed.
- (iv) Placards may be required for other dangerous properties of the contents.
- (v) An emergency telephone number along with the name of a person to be contacted in the event of an accident, shall be displayed on all placards.

### 5.3 Transport documents

- (i) Authority must be obtained from the Department to transport radioactive materials. Normally when an application is received to possess and use radioactive materials the Department automatically grants a "convey" and "cause to convey" authority. This gives the holder authority to transport the radioactive material himself, or to make use of a conveyor to transport it on his behalf.
- (ii) The transport documents shall:
  - (a) reflect all the information viz. activity, TI, type of label, type of radioactive material, etc. which appears on the labels on the package;
  - (b) contain the words "RADIOACTIVE MATERIAL";
  - (c) describe actions, if any, that are required from the carrier;
  - (d) contain details of procedures to be followed in the event of an emergency.
- (iii) Where transport documents refer to a "class or division of dangerous goods", the class must be specified as "7". If a UN number is requested, the appropriate number (see definitions) must be specified.

## 6 CONSIGNOR'S RESPONSIBILITY

The consignor (entity presenting package for transport) shall undertake and be responsible for the following:

- (i) He shall ensure that the transport documents are correctly completed.
- (ii) He shall ensure that the package is in a proper condition for transport and is in agreement with the transport requirements specified in the latest edition of IAEA Safety Series no 6.

## REFERENCES

- 1 Safety Series no. 6, IAEA Safety Standards, Regulations for the Safe Transport of Radioactive Material, 1985
- 2 Safety Series no. 80, IAEA Safety Guides, Schedule of Requirements for the Transport of Specified Types of Radioactive Material Consignments, 1986.
- 3 "Dangerous Goods Regulations", International Air Transport Association (IATA), 1991 edition.

ANNEXURE 1

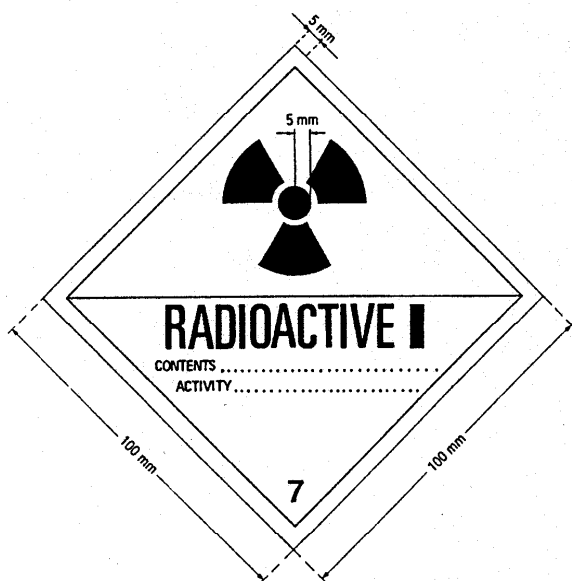


Fig 2: Category I-WHITE label. The background colour of the label shall be white, the colour of the trefoil and the printing shall be black, and the colour of the category bar shall be red.

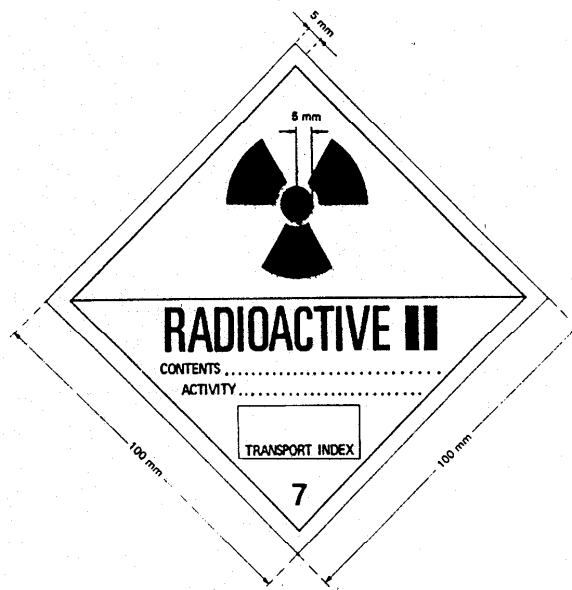


Fig 3: Category II-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

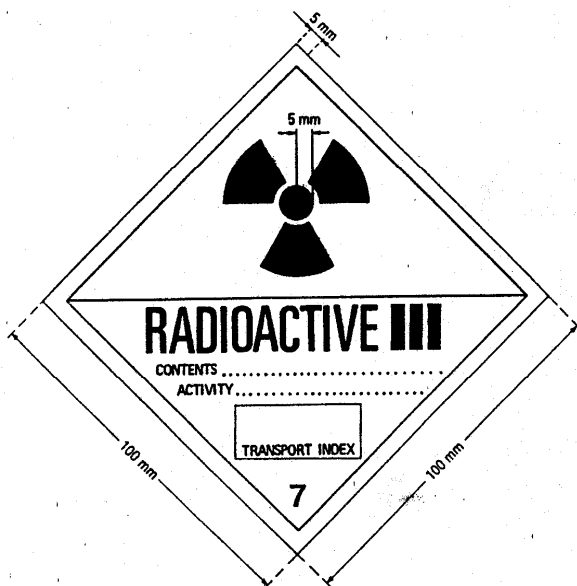


Fig 4: Category III-YELLOW label. The background colour of the upper half of the label shall be yellow and of the lower half white, the colour of the trefoil and the printing shall be black, and the colour of the category bars shall be red.

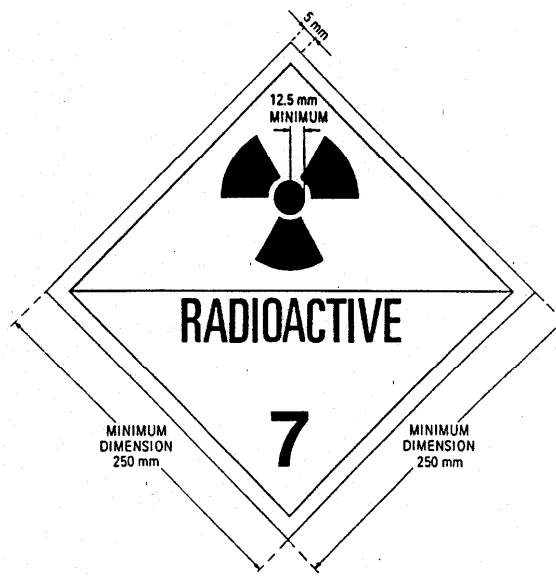


Fig 5: Placard. Minimum dimensions are given; when larger dimensions are used the relative proportions must be maintained. The figure '7' shall not be less than 25mm high. The background colour of the upper half of the placard shall be yellow and the lower half white, the colour of the trefoil and the printing shall be black.

**TABLE 4 ACTIVITY LIMITS**

Symbol of Isotope	Element and Atomic Number	A <sub>1</sub> Special Form		A <sub>2</sub> Other Forms	
		TBq	Ci	TBq	Ci
Ac-227	Actinium (89)	40	1000	0.00002	0.0005
Ac-228		0.6	10	0.4	10
Ag-105	Silver (47)	2	50	2	50
Ag-110m		0.4	10	0.4	10
Ag-111		0.6	10	0.5	10
Am-241	Americium	2	50	0.0002	0.005
Am-243		2	50	0.0002	0.005
Ar-37	Argon (18)	40	1000	40	1000
Ar-41		0.6	10	0.6	10
As-73	Arsenic (33)	40	1000	40	1000
As-74		1	20	0.5	10
As-76		0.2	5	0.2	5
As-77		20	500	0.5	10
At-211	Astatine (85)	30	800	2	50
Au-193	Gold (79)	6	100	6	100
Au-196		2	50	2	50
Au-198		3	80	0.5	10
Au-199		10	200	0.9	20
Ba-131	Barium (56)	2	50	2	50
Ba-133		3	80	3	80
Ba-133m		10	200	0.9	20
Ba-140		0.4	10	0.4	10
Be-7	Beryllium (4)	20	500	20	500
Bi-206	Bismuth (83)	0.3	8	0.3	8
Bi-207		0.7	10	0.7	10
Bi-210		0.6	10	0.5	10
Bi-212		0.3	8	0.3	8
Bk-249	Berkelium (97)	40	1000	0.08	2
Br-77	Bromine (35)	3	80	3	80
Br-82		0.4	10	0.4	10
C-11	Carbon (6)	1	20	0.5	10
C-14		40	1000	2	50
Ca-45	Calcium (20)	40	1000	0.9	20
Ca-47		0.9	20	0.5	10
Cd-109	Cadmium (48)	40	1000	1	20
Cd-115m		0.3	8	0.3	8
Cd-115		4	100	0.5	10
Ce-139	Cerium (58)	6	100	6	100
Ce-141		10	200	0.5	10
Ce-143		0.6	10	0.5	10
Ce-144		0.2	5	0.2	5
Cf-249	Californium (98)	2	50	0.0002	0.005
Cf-250		5	100	0.0005	0.01
Cf-252		0.1	2	0.001	0.02
Cl-36	Chlorine (17)	20	500	0.5	10
Cl-38		0.2	5	0.2	5
Cm-242	Curium (96)	40	1000	0.01	0.2

Symbol of Isotope	Element and Atomic Number	A <sub>1</sub> Special Form		A <sub>2</sub> Other Forms	
		TBq	Ci	TBq	Ci
Cm-244		4	100	0.0004	0.01
Cm-245		2	50	0.0002	0.005
Cm-246		2	50	0.0002	0.005
Co-56	Cobalt (27)	0.3	8	0.3	8
Co-57		8	200	8	200
Co-58m		40	1000	40	1000
Co-58		1	20	1	20
Co-60		0.4	10	0.4	10
Cr-51	Chromium (24)	30	800	30	800
Cs-129	Caesium (55)	4	100	4	100
Cs-131		40	1000	40	1000
Cs-132		1	20	1	20
Cs-134m		40	1000	9	200
Cs-134		0.6	10	0.5	10
Cs-135		40	1000	0.9	20
Cs-136		0.5	10	0.5	10
Cs-137		2	50	0.5	10
Cu-64	Copper (29)	5	100	0.9	20
Cu-67		9	200	0.9	20
Dy-165	Dysprosium (66)	0.6	10	0.5	10
Dy-166		0.3	8	0.3	8
Er-169	Erbium (68)	40	1000	0.9	20
Er-171		0.6	10	0.5	10
Eu-152m	Europium (63)	0.6	10	0.5	10
Eu-152		0.9	20	0.9	20
Eu-154		0.8	20	0.5	10
Eu-155		20	500	2	50
F-18	Fluorine (9)	1	20	0.5	10
Fe-52	Iron (26)	0.2	5	0.2	5
Fe-55		40	1000	40	1000
Fe-59		0.8	20	0.8	20
Ga-67	Gallium (31)	6	100	6	100
Ga-68		0.3	8	0.3	8
Ga-72		0.4	10	0.4	10
Gd-153	Gadolinium (64)	10	200	5	100
Gd-159		4	100	0.5	10
Ge-68	Germanium (32)	0.3	8	0.3	8
Ge-71		40	1000	40	1000
Ge-77		0.3	8	0.3	8
H-3	Hydrogen (1)	see T (Tritium)		see T (Tritium)	
Hf-175	Hafnium (72)	3	80	3	80
Hf-181		2	50	0.9	20
Hg-197m	Mercury (80)	10	200	0.9	20
Hg-197		10	200	10	200
Hg-203		4	100	0.9	20
Ho-163	Holmium (67)	40	1000	40	1000
Ho-166		0.3	8	0.3	8

Symbol of Isotope	Element and Atomic Number	A <sub>1</sub> Special Form		A <sub>2</sub> Other Forms	
		TBq	Ci	TBq	Ci
I-123	Iodine (53)	6	100	6	100
I-125		20	500	2	50
I-126		2	50	0.9	20
I-129		unlimited		unlimited	
I-131		3	80	0.5	10
I-132		0.4	10	0.4	10
I-133		0.6	10	0.5	10
I-134		0.3	8	0.3	8
I-135		0.6	10	0.5	10
In-111		Indium (49)	2	50	2
In-113m	4		100	4	100
In-114m	0.3		8	0.3	8
In-115m	Iridium (77)	6	100	0.9	20
Ir-190		0.7	10	0.7	10
Ir-192		1	20	0.5	10
Ir-193m		10	200	10	200
Ir-194		0.2	5	0.2	5
K-42	Potassium (19)	0.2	5	0.2	5
K-43		1	20	0.5	10
Kr-85m		6	100	6	100
Kr-85		20	500	10	200
Kr-87		0.2	5	0.2	5
La-140	Lanthanum (57)	0.4	10	0.4	10
LSA		Low specific activity material		Consult IAEA regs	
Lu-172	Lutetium (71)	0.5	10	0.5	10
MFP	Mixed fission products	Consult IAEA regs		Consult IAEA regs	
Mg-28	Magnesium (12)	0.2	5	0.2	5
Mn-52	Manganese (25)	0.3	8	0.3	8
Mn-54		1	20	1	20
Mn-56		0.2	5	0.2	5
Mo-99	Molybdenum (42)	0.6	10	0.5	10
N-13	Nitrogen (7)	0.6	10	0.5	10
Na-22	Sodium (11)	0.5	10	0.5	10
Na-24	Niobium (41)	0.2	5	0.2	5
Nb-93m		40	1000	6	100
Nb-95		1	20	1	20
Nb-97		0.6	10	0.5	10
Nd-147		Neodymium (60)	4	100	0.5
Nd-149	0.6		10	0.5	10
Ni-59	Nickel (28)	40	1000	40	1000
Ni-63		40	1000	30	800
Ni-65		0.3	8	0.3	8
Np-237	Neptunium (93)	2	50	0.0002	0.005
Np-239		6	100	0.5	10



Symbol of Isotope	Element and Atomic Number	A <sub>1</sub> Special Form		A <sub>2</sub> Other Forms	
		TBq	Ci	TBq	Ci
Os-185	Osmium (76)	1	20	1	20
Os-191m		40	1000	40	1000
Os-191		10	200	0.9	20
Os-193		0.6	10	0.5	10
P-32	Phosphorus (15)	0.3	8	0.3	8
Pa-230		Protactinium (91)	2	50	0.1
Pa-231	0.6		10	0.00006	0.001
Pa-233		5	100	0.9	20
Pb-201	Lead (82)	1	20	1	20
Pb-210		0.6	10	0.009	0.2
Li-212		0.3	8	0.3	8
Pd-103	Palladium (46)	40	1000	40	1000
Pd-109		0.6	10	0.5	10
Pm-147	Promethium (61)	40	1000	0.9	20
Pm-149		0.6	10	0.5	10
Pm-151		3	80	0.5	10
Po-210	Polonium (84)	40	1000	0.02	0.5
Pr-142	Praseodymium (59)	0.2	5	0.2	5
Pr-143		4	100	0.5	10
Pt-191	Platinum (78)	0.6	10	0.6	10
Pt-193m		40	1000	9	200
Pt-195m		10	200	2	50
Pt-197m		10	200	0.9	20
Pt-197		20	500	0.5	10
Pu-238*	Plutonium (94)	2	50	0.0002	0.005
Pu-239*		2	50	0.0002	0.005
Pu-240		2	50	0.0002	0.005
Pu-241*		40	1000	0.01	0.2
Pu-242		2	50	0.0002	0.005
Ra-223	Radium (88)	0.6	10	0.03	0.8
Ra-224		0.3	8	0.06	1
Ra-226		0.3	8	0.02	0.5
Ra-228		0.6	10	0.04	1
Rb-81	Rubidium (37)	2	50	0.9	20
Rb-86		0.3	8	0.3	8
Rb-87		unlimited		unlimited	
Rb (natural)		unlimited		unlimited	
Re-186	Rhenium (75)	4	100	0.5	10
Re-187		unlimited		unlimited	
Re-188		0.2	5	0.2	5
Re (natural)		unlimited		unlimited	
Rh-103m	Rhodium (45)	40	1000	40	1000
Rh-105		10	200	0.9	20
Rn-222	Radon (86)	0.2	5	0.004	0.1
Ru-97	Ruthenium (44)	4	100	4	100
Ru-103		2	50	0.9	20
Ru-105		0.6	10	0.5	10
Ru-106		0.2	5	0.2	5
S-35	Sulphur (16)	40	1000	2	50
Sb-122	Antimony (51)	0.3	8	0.3	8
Sb-124		0.6	10	0.5	10
Sb-125		2	50	0.9	20

Symbol of Isotope	Element and Atomic Number	A <sub>1</sub> Special Form		A <sub>2</sub> Other Forms	
		TBq	Ci	TBq	Ci
Sc-46	Scandium (21)	0.5	10	0.5	10
Sc-47		9	200	0.9	20
Sc-48		0.3	8	0.3	8
Se-75	Selenium (34)	3	80	3	80
Se-79		40	1000	2	50
Si-31	Silicon (14)	0.6	10	0.5	10
Si-32		40	1000	0.2	5
Sm-147	Samarium (62)	unlimited		unlimited	
Sm-151		40	1000	4	100
Sm-153		4	100	0.5	10
Sn-113	Tin (50)	4	100	4	100
Sn-119m		4	1000	40	1000
Sn-125	Strontium (38)	0.2	5	0.2	5
Sr-85m		5	100	5	100
Sr-85		2	50	2	50
Sr-87m		3	80	3	80
Sr-89		0.6	10	0.5	10
Sr-90		0.2	5	0.1	2
Sr-91		0.3	8	0.3	8
Sr-92		0.2	5	0.2	5
T (all forms)	Tritium (1)	40	1000	40 and for liq, conc. < 1TBq/l	1000 and for liq, conc. < 20 Ci/l
Ta-182	Tantalum (73)	0.8	20	0.5	10
Tb-160	Terbium (65)	0.9	20	0.5	10
Tc-96m	Technetium (43)	0.4	10	0.4	10
Tc-96		0.4	10	0.4	10
Tc-97m		40	1000	40	1000
Tc-97		unlimited		unlimited	
Tc-99m		8	200	8	200
Tc-99		40	1000	0.9	20
Te-123m	Tellurium (52)	7	100	7	100
Te-125m		30	800	9	200
Te-127m		20	500	0.5	10
Te-127		20	500	0.5	10
Te-129m		0.6	10	0.5	10
Te-129		0.6	10	0.5	10
Te-131m		0.7	10	0.5	10
Te-132		0.4	10	0.4	10
Th-227	Thorium (90)	9	200	0.01	0.2
Th-228		0.3	8	0.0004	0.01
Th-230		2	50	0.0002	0.005
Th-231		40	1000	0.9	20
Th-232		unlimited		unlimited	
Th-234		0.2	5	0.2	5
Th (natural)		unlimited		unlimited	
Ti-44		Titanium (22)	0.5	10	0.2
Tl-200	Thallium (82)	0.8	20	0.8	20
Tl-201		10	200	10	200

Symbol of Isotope	Element and Atomic Number	A <sub>1</sub> Special Form		A <sub>2</sub> Other Forms	
		TBq	Ci	TBq	Ci
Tl-202		2	50	2	50
Tl-204		4	100	0.5	10
Tm-170	Thulium (69)	4	100	0.5	10
Tm-171		40	1000	10	200
U-230	Uranium (92)	40	1000	0.01	0.2
U-232		3	80	0.0003	0.008
U-233*		10	200	0.001	0.02
U-234		10	200	0.001	0.02
U-235*		unlimited		unlimited	
U-236		10	200	0.001	0.02
U-238		unlimited		unlimited	
U (natural)		unlimited		unlimited	
U (enriched - 5% or less)*		unlimited		unlimited	
U (enriched - more than 5%)*		10	200	0.n 1	0.02
U (depleted)		unlimited		unlimited	
V-48	Vanadium (23)	0.3	8	0.3	8
W-181	Tungsten (74)	30	800	30	800
W-185		40	1000	0.9	20
W-187		2	50	0.5	10
Xe-127	Xenon (54)	4	100	4	100
Xe-131m		40	1000	40	1000
Xe-133		20	500	20	500
Xe-135		4	100	4	100
Y-87	Yttrium(39)	2	50	2	50
Y-90		0.2	5	0.2	5
Y-91m		2	50	2	50
Y-91		0.3	8	0.3	8
Y-92		0.2	5	0.2	5
Y-93		0.2	5	0.2	5
Yb-169	Ytterbium (70)	3	80	3	80
Yb-175		30	800	0.9	20
Zn-65	Zinc (30)	2	50	2	50
Zn-69m		2	50	0.5	10
Zn-69		4	100	0.5	10
Zr-93	Zirconium (40)	40	1000	0.2	5
Zr-95		1	20	0.9	20
Zr-97		0.3	8	0.3	8

\* Fissile material subject to additional requirements specified in IAEA regulations (5.7.52-60).