

TRANSPORT OF RADIOACTIVE MATERIALS

1. INTRODUCTION

These guidance notes are an interpretation of the requirements of the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations SI 2009 No.1348 (CDG2009) as they affect the transport of radioactive materials by road. CDG2009 came into force on the 1st July 2009 and replaced CDG2007 and the previously separate Radioactive Material (Road Transport) (Great Britain) Regulations SI 2002 No.1093.

These Regulations are based upon the International Atomic Energy Agency's (IAEA) Regulations for the Safe Transport of Radioactive Materials (Safety Series No.TS-R-1) and the European Agreement re the International Carriage of Dangerous Goods by Road (ADR).

The basic philosophies behind the Regulations are that :-

- a) package design should be such that the risk of any radioactive contamination or external radiation hazard should be kept to a minimum
- b) that all shipments should be traceable back to the sender
- c) that good quality assurance should produce public reassurance.

Main Implications of the Regulations

1. There is a category of exempt radioactive material that defines what is significant radioactive material under the transport regulations and is radionuclide specific.
2. As there is no requirement to provide information to the carrier in relation to the transport of excepted packages, it would appear that it is now possible to use public transport whilst transporting an excepted package. Excepted packages only need to be marked up with the appropriate UN number and consignor or consignee details.
3. There is no professional user exemption and all persons must therefore conform fully with all the requirements of the regulations, but, display of smaller placards is allowed for cars (and other small vehicles up to 3500kg) carrying labelled packages.
4. Consignment notes are required for all categories of radioactive package above excepted packages.
5. The UN numbers and descriptors have been expanded so that they are more specific. All NOS (not otherwise specified) numbers have been de-listed.
6. . There is a requirement for carrying fire extinguishers when carrying more than 10 labelled (Type A) packages where the combined Transport Index (TI) is greater than 3. When the TI >3 or more than 10 packages are being carried normal ADR requirements apply.
7. The Department for Transport have the power to inspect premises as well as vehicles, to ensure compliance with CDG2009 but the Health and Safety Executive are now the main enforcing authority.
8. Contamination limits remain the same for all types of package.

Definitions

Radioactive substance - no definition of what constitutes a radioactive substance is actually given in the regulations but what is radiologically significant is implied by the description of what constitutes exempt material. This varies with the radiotoxicity of the nuclide with some alpha emitters it is only 0.1Bq/g but for tritium it is 1 MBq/g. (see Table 1 below)

Road means any highway to which the public has unrestricted access. Therefore in a campus university if there are barriers to get passed before gaining access to the site, transport on the internal roads are not covered by the Regulations.

Transport of packages in these regulations covers much more than the transportation procedure and also includes the design, fabrication and maintenance of packaging, and the preparation, consigning, handling, carriage, storage in transit and receipt at the final destination of packages.

Transport Index (TI) is an indication of the external hazard that a package presents. It represents the maximum dose rate at 1 metre from a package measured in mSv/h and multiplied by 100. (i.e. it is the dose rate at 1 metre in the old mrem/h units)

Consignor is the person sending the goods and the *Consignee* is the recipient of the goods.

A full and extensive description of all terms used in the regulations can be found for Class 7 Radioactive Material in section 2.2.7.1 of the ADR.

Scope of the Regulations

The regulations cover the transport by road of all non-exempt radioactive material in the form of sources or waste conveyed in a vehicle both within the UK and for journeys in other European countries covered by the ADR (an ADR journey). There are some exceptions to this and relevant ones are as follows:-

- transport on private roads
- transport of radioactive material contained in the body of a person undergoing medical treatment, a dead person or a live animal undergoing medical treatment
- transport of approved consumer products by a consumer
- transport in accordance with an approved derogation

2. EXEMPT RADIOACTIVE MATERIALS

TABLE 1 - Activity Limits For Exempt Radioactive Materials

| Nuclide | Activity concentration for exempt material (Bq/g) | Activity limit for an exempt consignment (Bq) |
|----------------|--|--|
| H-3 | 1×10^6 | 1 GBq |
| C-14 | 1×10^4 | 10 MBq |
| P-32 | 1×10^3 | 100 kBq |
| P-33 | 1×10^5 | 100 MBq |
| S-35 | 1×10^5 | 100 MBq |
| Ca-45 | 1×10^4 | 10 MBq |
| Cr-51 | 1×10^3 | 10 MBq |
| Fe-55 | 1×10^4 | 1 MBq |
| Fe-59 | 1×10^1 | 1 MBq |
| Co-57 | 1×10^2 | 1 MBq |
| Co-60 | 1×10^1 | 100 kBq |
| Ni-63 | 1×10^5 | 100 MBq |
| Rb-86 | 1×10^2 | 100 kBq |
| Tc-99m | 1×10^2 | 10 MBq |
| I-125 | 1×10^3 | 1 MBq |
| I-131 | 1×10^2 | 1 MBq |

For a shipment to be exempt either the activity concentration must be less than that specified in col 2 of Table 1 or the total activity in the consignment does not exceed the value specified in col 3 of Table 1 (see above).

NB the limits apply to a consignment and are not package limits. This condition can only realistically be applied where the consignor and the carrier are the same person as an independent carrier will have no knowledge of the contents of an exempt package or how many, if any, they are carrying.

3. TRANSPORT OF EXCEPTED PACKAGES

It should be noted that the Regulations do not differentiate between radioactive sources and radioactive waste when it comes to excepted package quantities. As long as the waste fulfils the requirements for excepted packages it can be transported as such.

The bulk of university transport requirements will be covered by excepted packages.

Activity Limits for Excepted Packages

As long as the packaging and documentation requirements are met in full, radioactive material in liquid or solid form with an activity not exceeding that given in Table 2 and a surface dose rate not exceeding 5 μ Sv/h, may be transported in an excepted package. When either of these criteria are exceeded then the material must be transported in a Type A package or an industrial package as appropriate.

TABLE 2 Activity Limits For Excepted Packages

| Nuclide | Ordinary Solid Form | Liquid Form |
|----------------|----------------------------|--------------------|
| H-3 | 40 GBq | 4 GBq |
| C-14 | 3 GBq | 300 MBq |
| P-32 | 0.5 GBq | 50 MBq |
| P-33 | 1 GBq | 100 MBq |
| S-35 | 3 GBq | 300 MBq |
| Ca-45 | 1 GBq | 100 MBq |
| Cr-51 | 30 GBq | 3 GBq |
| Fe-55 | 40 GBq | 4 GBq |
| Fe-59 | 900 MBq | 90 MBq |
| Co-57 | 10 GBq | 1 GBq |
| Co-60 | 400 MBq | 40 MBq |
| Ni-63 | 30 GBq | 3 GBq |
| Rb-86 | 500 MBq | 50 MBq |
| Tc-99m | 4 GBq | 400 MBq |
| I-125 | 3 GBq | 300 MBq |
| I-131 | 700 MBq | 70 MBq |

NB For special form solid radioactive materials there are higher limits. For instruments containing radioactive materials the individual item limits are ten times the above limits. For

gases the limits are the same as for solids, with the exception of tritium where there is a higher limit. A full list of limits for all radionuclides can be extrapolated from Table 2.2.7.2.2.1 of the ADR by using the factors given in Table 2.2.7.2.4.1.2.

General Packaging Requirements

a) When necessary, shielding should be provided to ensure that the dose rate at the surface of the excepted package does not exceed $5\mu\text{Sv/h}$.

For instruments or manufactured articles containing an excepted quantity of radioactive material the above dose rate limit does not apply, but the dose rate 10cm from any external point of any unpackaged instrument or article should not exceed 0.1mSv/h

b) Non-fixed contamination of the external surface of the excepted package shall not exceed:-

i. 4Bq/cm^2 for beta, gamma and low toxicity alpha emitters, e.g. natural uranium and thorium;

ii. 0.4Bq/cm^2 for all other alpha emitters.

c) 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.

d) The package shall be so designed in relation to its mass, volume and shape that it can be easily and safely handled and retain its contents under conditions likely to be encountered in routine transport, eg taking into account acceleration, vibration and braking. The volume of absorbent material should be always at least twice that of a liquid sample.

e) As far as practicable, the packaging shall be so designed and finished that the external surfaces are free from protruding features and can be easily decontaminated.

f) As far as practicable, the outer layer of the package shall be so designed as to prevent the collection and retention of water.

g) Any features added to the package at the time of transport which are not part of the package shall not reduce its safety.

h) The materials of the packaging and any components or structures shall be physically and chemically compatible with each other and with the radioactive contents. If applicable account shall be taken of their behaviour under irradiation.

i) In addition to the radioactive properties, any other dangerous properties of the contents of the package, such as explosive nature, flammability, pyrophoricity, chemical toxicity and corrosiveness, shall be taken into account in the packing.

j) If the gross weight of the package exceeds 50kg then the maximum weight shall be clearly marked on the package.

NB Additional labelling requirements might be required by the relevant Transport Regulations for Dangerous Goods, i.e. The Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 (CHIP 3).

Meeting the Packaging Requirements

The screw top cans now used by Amersham are ideal for re-use, as are some of the moulded polystyrene blocks used by other manufacturers. NB if they are being sent to another establishment, then the original suppliers name should be obliterated. As an alternative, polythene/polypropylene bottles or jars with screw fittings or other tight-fitting lids might prove useful. Examples of suitable excepted package designs are given in Figs 1 & 2 below.

FIG 1 Example of Excepted Package

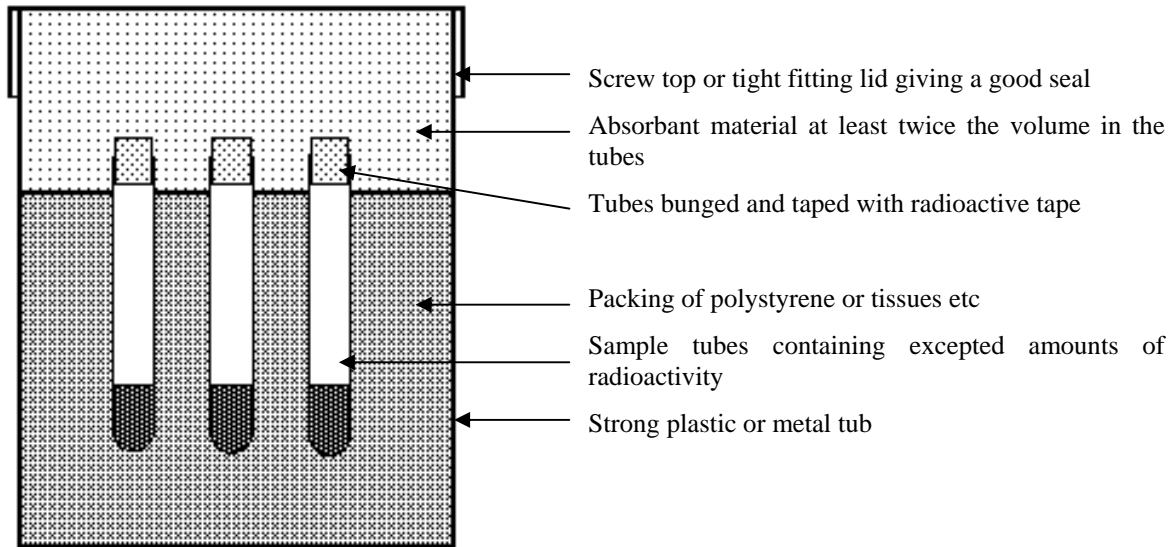
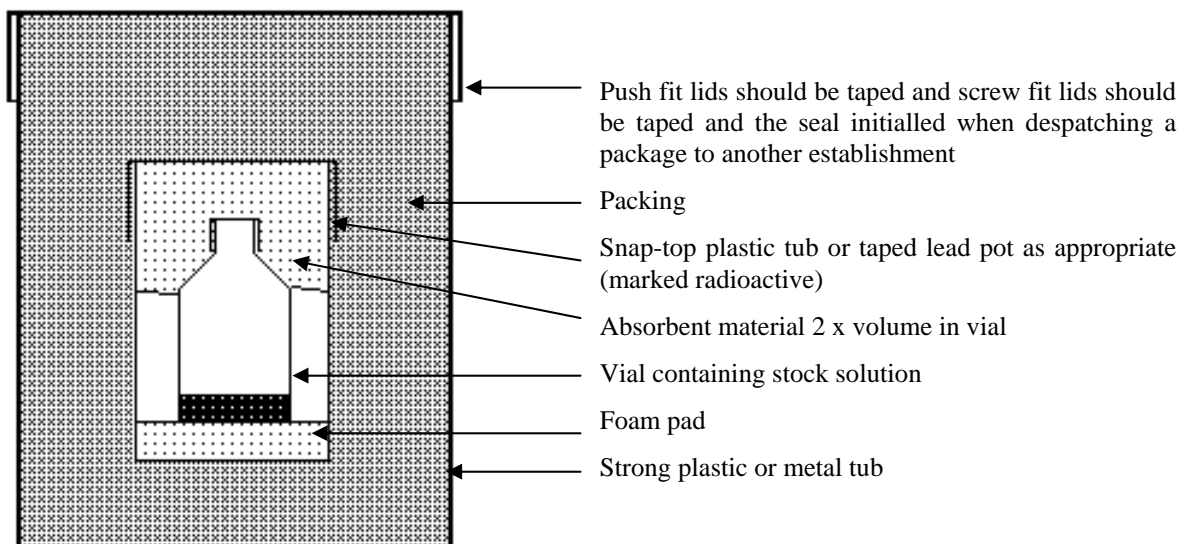


FIG 2 Example of Type A Package



Recommended minimum dimension of outer packaging is 10cms.

NB The packaging shown in Fig2 should meet the requirements for a Type A package provided it is robust enough to withstand the appropriate performance tests.

Transport Documents and Labelling requirements

All items and materials transported as excepted packages shall be described in the transport documents with the appropriate UN number and shipping name e.g.

- UN 2910 *Radioactive Material, Excepted Package - Limited Quantity of Material*
- UN 2908 *Radioactive Material, Excepted Package - Empty Packaging*
- UN 2909 *Radioactive Material, Excepted Package - articles manufactured from natural or depleted uranium or natural thorium*
- UN 2911 *Radioactive Material, Excepted Package - instruments and articles*

There should also be details of the consignor and consignee, the date of shipment and a signed declaration by the consignor (facsimile signature allowed). See example consignment note in Appendix 2. *(NB there is not now a specific legal requirement for this but it may be used as a useful part of a QA program for excepted packages in that it should signify that the basic design requirements have been met.)*

In order to fully comply with the requirements of the transport regulations and the Ionising Radiation Regulations 1999, the following additional information should accompany an excepted package:

- a reference to the applicable transport regulations
- emergency contact details of consignor
- a description of the radioactive substance, e.g. the radionuclide, its activity on a specified date and its chemical and physical form;
- any additional information which would be required to enable the person opening it to do so safely.

The above will more than meet the requirements of the regulations and, as the UN number and either the consignee or consignor details must be displayed on the outside of the package, it is recommended that a label is made up as in Fig 3 (below) for attachment to the outside of the package.

NB If the transport operation involves air travel the IATA regulations must be observed and these have now introduced their own label for excepted packages see Fig 4. In these circumstances it is advised that just this label should be used.

Any additional information that may be required can be included in an accompanying letter or technical note that should be found immediately on opening the package.

There is no specific requirement for a record to be kept of shipments of excepted packages but there is of course the requirement under RSA93 to keep records of transfers of radioactive material for 4 years (5 years in Scotland). There is no longer a requirement to keep records relating to measurements of contamination of consignments but again one may want to keep a record for QA purposes. Therefore in order to meet this requirement it may be prudent to continue to keep a log of shipments combined with contamination measurements. All that should be needed is a statement that contamination is less than the permitted level. This will also be satisfactory for a record of other shipments - see example Table 3 below.

FIG 3 Label/Consignment Note for Excepted Packages

| | |
|--|--------------------|
| The Carriage of Dangerous Goods etc Regulations 2007 | |
| UN 2910 | |
| Date | Physical form..... |
| Isotope..... | Chemical form..... |
| Activity..... | |
| Dispatched by - UNIV of SHEFFIELD, DEPT of Postcode | |
| Contact | Tel |
| Deliver to | |
| | |
| I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name, and are classified, packed, marked and labelled, and are in all respects in proper condition for transport by road according to the applicable international and national governmental regulations. | |
| For the Consignor | |

Fig 4 Transport Label for Excepted Package (IATA)

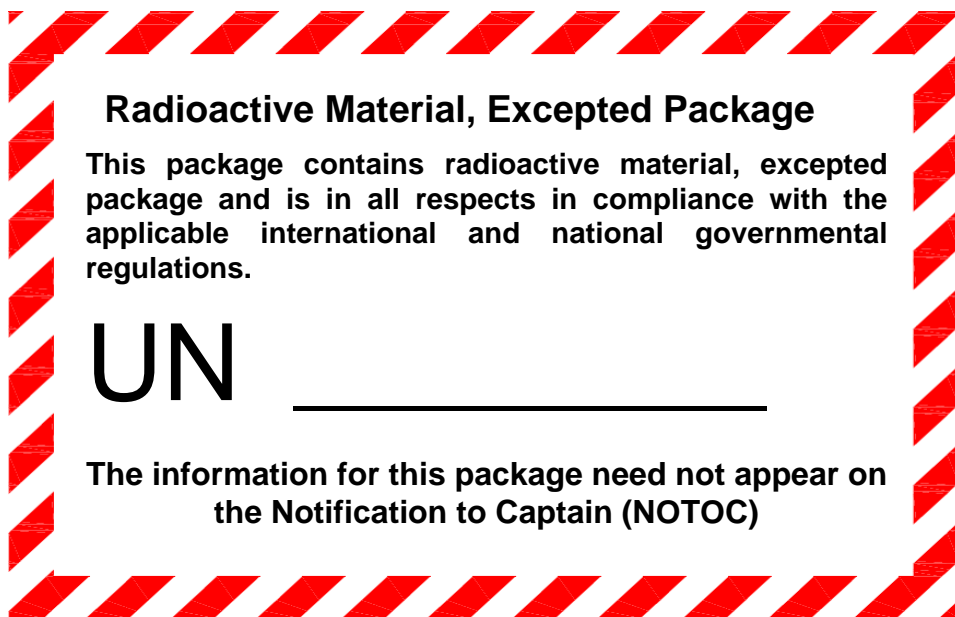


TABLE 3 Log Of Radioactive Material Consignments

| Date | Type of shipment | Type of material | No. of packages | TI | Contamination check |
|-------------|-------------------------|-------------------------|------------------------|-----------|----------------------------|
| 19.08.02 | Exempt | Beta | 4 | N/A | <4Bq/cm ² |
| 20.08.02 | Type A | Alpha | 1 | 0 | <0.4Bq/cm ² |
| 20.08.02 | IP-2 (waste) | Beta/gamma | 10 | 0 | <4Bq/cm ² |
| | | | | | |

There are no requirements for the placarding of vehicles either internally or externally when transporting excepted amounts of radioactive material. However, please remember before transporting any radioactive material by car, check your car insurance policy (note there is a distinction between ‘irradiated nuclear fuel’ and other radioactive materials).

There is no requirement for carrying a fire extinguisher for small loads of upto 10 packages. If carrying more than 10 excepted packages then one 2kg dry powder extinguisher must accompany the load.

There are no restrictions regarding: the mixed contents of packages, carrying a mixed load on the vehicle, travel of persons in the vehicle or parking of the vehicle.

4. TRANSPORT OF TYPE A PACKAGES

Contact Safety Services if you think you are going to be involved in the transport of Type A packages. Safety Services will advise on the packaging, categorisation, labelling and transport documents for these packages. All Type A packages (and higher categories) require labelling of the packages with the radiation trefoil and the display of vehicle placards.

5. REFERENCES

1. The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG2009) <http://www.opsi.gov.uk/si/si2009/20091348.htm>
2. The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR). http://www.unece.org/trans/danger/publi/adr/adr_e.html
3. IAEA Safety Standards Series No. TS-G-1.1 (ST-2) - Advisory material for the IAEA Regulations for the Safe Transport of Radioactive Material. <http://www-ns.iaea.org/standards/documents/default.asp?sub=200>

RADIOISOTOPE DELIVERIES - DRIVERS' RESPONSIBILITIES

These guidelines have been drawn up from the requirements of the Carriage of Dangerous Goods etc Regulations 2009 (CDG2009), taking into account the type of material which we usually transport and our in-house administrative arrangements.

General

The driver is in charge of the vehicle and is responsible for the safe transport of the goods he is carrying. He should ensure that none of the material is lost, escapes or is unlawfully removed from the vehicle or from any package. All vehicle crew to wear photo ID badge.

Safety Equipment

When transporting labelled radioactive packages (Type A) make sure that the van is equipped with:

- 2 x 2kg dry powder FXs,
- one wheel chock suitable for the size of vehicle,
- 2 self-standing warning triangles
- eye-wash

and that each member of the crew is provided with:

- a hi-vis jacket (see EN 471)
- a torch
- protective gloves; and
- eye protection (e.g. protective goggles)

Guarding the Vehicle

When in a public place, the driver must not leave unattended or out of sight any vehicle containing radioactive material, without reasonable cause. If he should have to leave the vehicle, the storage compartment must be locked or the packages otherwise secured so as to prevent unlawful removal.

Stowage of Goods

The driver should ensure that the packages are not roughly treated, and are properly stowed. It is permitted to carry non-dangerous goods in the same vehicle (other dangerous goods and photographic film are not permitted). However, radioactive goods should be stowed together and not intermingled with non-radioactive goods. In a mixed load, the radioactive materials should always be to the rear of the vehicle.

Display of Placards and Notices

The driver must ensure that the fireproof warning notice is exhibited in the cab and that the vehicle placards are properly displayed (each side and rear of the vehicle). The vehicle placards or cab notice are not required when only transporting excepted packages. Excepted packages can easily be recognised as they **do not** have radiation warning signs on them.

Signing for and Hand-over of Goods

When the radioisotopes are collected from Safety Services, the driver will be given an inventory of the packages he is taking. He should check that the number of packages he receives tallies with that displayed on the inventory before signing for them. When delivering the isotopes, he should ensure that they are handed over to an authorised recipient, and that they are signed for.

NB - Always keep these instructions readily to hand. PTO for Emergency Actions.

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ACTIONS IN THE EVENT OF AN ACCIDENT OR EMERGENCY

In the event of an accident or emergency that may occur or arise during carriage the vehicle crew shall take the following actions where safe and practicable to do so:

- Apply the braking system, stop the engine
- Avoid sources of ignition, in particular do not smoke or switch on any electrical equipment
- The driver must notify Emergency Control Centre, Sheffield **(0114) 2728887** immediately if he suspects that:
 - a) any radioactive material has been lost, stolen, or has escaped from the vehicle;
 - b) any package containing radioactive material has been damaged in a road accident or otherwise; or
 - c) the vehicle and its load is in danger e.g. from fire;
 and give details of the radioactive material involved and any other relevant information.
- Put on the warning vests and place the self standing warning signs as appropriate
- Keep the transport documents readily available for responders on arrival
- Do not walk into or touch spilled substances and avoid inhalation of fumes, smoke, dusts and vapours by staying up wind
- Where appropriate and safe to do so, use available fire extinguishers to put out small/initial fires in tyres, brakes and engine compartment
- Fires in load compartment shall not be tackled by members of vehicle crew
- Move away from the vicinity of the accident or emergency, advise other persons to move away and follow the advice of the emergency services
- Remove any contaminated clothing and used contaminated protective equipment and dispose of it safely.



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| Radioactive materials being carried risk of intake and external radiation in an accident. | Limit time of exposure. Keep at a safe distance. |
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