

ONR GUIDE			
<b>THE CARRIAGE OF DANGEROUS GOODS AND USE OF TRANSPORTABLE PRESSURE EQUIPMENT REGULATIONS 2009 – RADIATION AND CONTAMINATION MONITORING, AND DETERMINATION OF TRANSPORT INDEX</b>			
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## **1. INTRODUCTION**

- 1.1 The carriage of dangerous goods by road and rail in Great Britain, including radioactive materials, is regulated by the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (Statutory Instrument 2009 No. 1348), also referred to as CDG 2009. CDG 2009 Regulation 32A makes it an offence for a person not to comply with any relevant provision as they apply to the civil carriage of class 7 (radioactive materials) dangerous goods.
- 1.2 The enactment in Great Britain of the international requirements defined in both ADR and RID is via CDG 2009, Regulation 5. ADR and RID establish standards of safety which provide an acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment that are associated with the carriage of radioactive material. These standards are based on the IAEA Regulations for the Safe Transport of Radioactive material, 2012 Edition, IAEA Safety Standards Series No. SSR-6, IAEA, Vienna (2012). Explanatory material can be found in “Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)”, IAEA Safety Standards Series No. SSG-26, IAEA, Vienna (2014). These publications are considered Relevant Good Practice (RGP) and ONR’s policy is to reflect these standards and to encourage duty holders to use them where appropriate.
- 1.3 IAEA Specific Safety Guide No. SSG-26 Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition), IAEA Safety Guide No. TS-G-1.3 Radiation Protection Programmes for the Transport of Radioactive Material, and IAEA Safety Guide No. TS-G-1.5 Compliance Assurance for the Safe Transport of Radioactive Material. This guide is based upon such publications.
- 1.4 ONR inspects compliance with CDG 2009, and also with the arrangements made under them, to judge the suitability of the arrangements made and the adequacy of their implementation. To support inspectors undertaking compliance inspections, ONR produces a suite of guides to assist inspectors to make regulatory judgements and decisions in relation to the adequacy of compliance, and the safety of duty holder activities. This inspection guide is part of that suite of documents and provides guidance for inspections against CDG 2009.

## **2. PURPOSE AND SCOPE**

- 2.1 This guide has been prepared as an aid to inspection activities carried out by ONR inspectors at duty holder premises, and other relevant places, in judging the duty holder’s compliance with the requirement for contamination and radiation monitoring of packages, packagings, overpacks, containers, tanks, intermediate bulk containers (IBCs) and conveyances, and subsequent determination of transport index (TI), as required by ADR / RID via CDG 2009 Regulation 5.
- 2.2 This guidance provides a framework for these inspection activities, within which the inspector is able to exercise their discretion. This framework is provided to facilitate a consistent approach to compliance inspection of CDG 2009.

- 2.3 The guidance is for use by inspectors in ONR. The guidance does not indicate when or to what extent inspections of the requirements of CDG 2009 should be carried out, as these matters are covered in individual inspector's inspection plans, which take account of priorities established by the relevant ONR Programme.
- 2.4 A compliance inspection of a nuclear licensed site may be topic specific, such as an inspection of the arrangements for contamination and radiation monitoring, and subsequent determination of transport index; however an inspection of other duty holders is likely to cover a range of topics. Some aspects (e.g. documentary information) may not necessarily be inspected at the premises.
- 2.5 The remainder of the Guide is set out in six sections, as below:
- Section 3: CDG 2009 - Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009
  - Section 4: Purpose of The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009),
  - Section 5: Guidance on Inspection of Arrangements and Their Implementation for CDG 2009,
  - Section 6: Further Reading,
  - Section 7: Definitions
  - Annex A: Guidance on Arrangements for Contamination and Radiation Monitoring, and Subsequent Determination of Transport Index for ADR / RID (via CDG 2009)

### **3. THE CARRIAGE OF DANGEROUS GOODS AND USE OF TRANSPORTABLE PRESSURE EQUIPMENT REGULATIONS 2009 (CDG 2009)**

- 3.1 The relevant regulatory requirements concerning the civil carriage of class 7 goods by road and rail in Great Britain are set out in Statutory Instrument 2009 No 1348 and subsequent amending Regulations. Regulation 5 requires that no person is to carry dangerous goods, or cause or permit dangerous goods to be carried, where that carriage is prohibited by ADR (European Agreement Concerning the International Carriage of Dangerous Goods by Road) or RID (Regulations Concerning the International Carriage of Dangerous Goods by Rail), including where that carriage does not comply with any applicable requirements of ADR / RID. Inspectors should consult these documents in preparing for and carrying out their compliance inspection.
- 3.2 The Office for Nuclear Regulation is the Competent Authority for those functions in relation to the carriage of class 7 for which the Secretary of State for Defence is not the competent authority, except for the function in sub-section 1.10.1.6 of ADR (register of driver training certificates). The GB competent authority is to perform those functions that are identified in ADR, RID and ADN as being the functions of a competent authority.

3.3 The CDG 2009 regulations themselves, as made, are available on the internet at <http://www.legislation.gov.uk/ukxi/2009/1348/contents/made>. These regulations are subject to revision and up to date versions of legislation is available to inspectors via [www.westlaw.co.uk](http://www.westlaw.co.uk).

#### **4. PURPOSE OF THE CARRIAGE OF DANGEROUS GOODS AND USE OF TRANSPORTABLE PRESSURE EQUIPMENT REGULATIONS 2009 (CDG 2009)**

4.1 Regulation 5, in essence, requires that carriage of dangerous goods is to be in accordance with ADR or RID, as applicable. The objective of ADR / RID is to establish requirements that shall be satisfied to ensure safety and to protect persons, property and the environment from the effects of radiation in the carriage of radioactive material. This protection is achieved by requiring:

- (a) Containment of the radioactive contents;
- (b) Control of external radiation levels;
- (c) Prevention of criticality;
- (d) Prevention of damage caused by heat.

4.2 These requirements are satisfied firstly by applying a graded approach to contents limits for packages and conveyances and to performance standards applied to package designs depending upon the hazard of the radioactive contents. Secondly, they are satisfied by imposing conditions on the design and operation of packages and on the maintenance of packagings, including a consideration of the nature of the radioactive contents. Finally, they are satisfied by requiring administrative controls, including, where appropriate, approval by competent authorities.

4.3 Duty holders are required to comply with these Regulations. How this compliance is achieved is for the duty holder to decide. However, ONR must judge the adequacy of this compliance. ONR carries out this function by compliance inspection.

#### **5. GUIDANCE ON INSPECTION OF ARRANGEMENTS AND THEIR IMPLEMENTATION FOR CDG 2009**

##### **General**

5.1 This part of this guidance is to assist inspectors in judging the adequacy of the duty holder's arrangements. These arrangements must be implemented adequately. This section is neither exclusive nor exhaustive and will be subject to review and revision in the light of operational experience. It does, however, provide aspects of ADR / RID (via CDG 2009) that can be examined during routine inspections of contamination and radiation monitoring, and subsequent determination of transport index (TI).

5.2 Check that arrangements are in place and procedures have been made to demonstrate compliance with the requirements of ADR / RID (via CDG 2009) that can be examined during routine inspections of contamination and radiation monitoring, and subsequent determination of transport index (TI), that they include

the review and, whenever necessary, revision of such arrangements. Check that these arrangements are readily available, up-to-date, implemented adequately, as set out in the remainder of this section.

5.3 If duty holders have generic models for such arrangements then it is for the duty holder to justify any deviation from the models. Any such deviations must comply with the requirements of CDG 2009, and hence also ADR / RID. Duty holders may have generic (corporate) arrangements in place but, due to operational reasons, for example, they may not be applicable in certain circumstances, therefore they have adopted alternative arrangements (deviations).

- Are the reasons given for deviating from generic arrangements reasonable, and not just because they are perceived as difficult to comply with?
- Check that any deviations have been adequately justified.

5.4 Review the procedures to establish their validity, whether any changes have been made since the last review and, where applicable, whether the identified responsible persons are correct and whether there are any omissions. Note whether instructions, methods and management system requirements claimed in procedures have been followed and whether any changes that have been made have been correctly incorporated and validated.

5.5 Have users of monitoring instruments / detectors developed specific measurement techniques relevant to their particular circumstances? Such techniques may include the use of wipes and appropriate survey instruments. The instruments and detectors should be selected to take into account the radionuclides to be measured.

5.5.1 A review of the justification of the measurement techniques should be limited to determining whether the author is qualified to undertake such an assessment, and that certain, specific considerations have been included. However, any concerns, inconsistencies and / or omissions regarding the competency of the person undertaking the assessment should be raised with the ONR or HSE RP specialist inspectors as appropriate.

Examples could include:

- a) Has the duty holder assessed and addressed all reasonably foreseeable contamination issues?
  - Does the duty holder only measure where they expect to find contamination or do they also check other areas where it is possible to become contaminated?
  - Do such techniques include the use of wipes and appropriate survey instruments?
  - Has consideration been given to the number of wipe samples to ensure that measurements taken are representative of the whole surface? An example of when this might occur is when routine surveys of very large packages, such as irradiated fuel flasks, is undertaken as it is common practice to select a

large number of fixed general positions to assist in identifying patterns and trends.

- For routine surveys on a very large package, such as an irradiated fuel flask, care ought be taken so that the identical position is not wiped on successive occasions since this would leave large areas unchecked and would tend to 'clean' those areas that are checked.
  - Is direct monitoring for contamination used (rare), and if so, is it included in this justification?
  - Do the instruments and detectors selected take into account the likely radionuclides to be measured?
- b) Has the duty holder assessed and addressed all reasonably foreseeable radiation issues?
- Does the duty holder only measure where they expect to find higher levels of radiation or do they also check other areas where it is possible for higher levels of radiation to be encountered?
  - Do the instruments and detectors selected take into account the likely radionuclides to be measured?
- c) Has consideration been given to the suitability of the instrumentation with respect to the geometry of the package, the overpack, the freight container, etc., to be measured? For example, finned packages may result in narrow radiation beams;
- d) Has consideration been given to the suitability of the instrumentation with respect to the size (it ought to be small in relation to the dimensions of the package or overpack)?
- e) Has a competent person assessed such techniques and practices and deemed them adequate? What evidence is there of this?
- f) A qualified person must assess the extent of contamination and resultant radiation level of a package that is damaged or leaking, or suspected to have leaked or been damaged, and, where necessary, ensure additional steps to overcome and minimise the consequences of such leakage or damage at taken. Who has the duty holder determined will undertake this?
- What competency assessment (which may include function specific training) has been undertaken?
  - What evidence is there of this and is it adequate?

5.6 In order to assess the adequacy of the monitoring equipment used to measure the radiation levels and / or contamination levels of the package, the overpack, the freight container, etc., considerations could include, but not necessarily be limited to:

- a) is it suitable for (sensitive to) the types of radiation encountered – for example;
  - Is account made of neutron dose where neutrons are expected?
  - Are appropriate gamma radiation level monitors used where gamma radiation is expected?
- b) Is non-fixed contamination determined by wiping a 300cm<sup>2</sup> area with an appropriate material (filter paper, wad of dry cotton wool, etc.)?
  - Has the methodology been suitably assessed by a competent person?
  - What evidence is there of this and is it adequate?
- c) Is it functioning correctly – is the battery(ies) charged? Does it switch on? Is the expected reading displayed (zero, background, or is it elevated / spurious)?
- d) Has it been maintained? Is it reliable? Is it in good condition? Has it been maintained adequately?
- e) Has the calibration been checked? Is it in date? Is evidence of the check available (certificate, calibration stickers on instrumentation etc.)?
  - If the monitoring equipment has not been checked for over a year and is being used to measure radiation levels in a controlled area then also inform ONR or HSE RP specialist inspectors regarding potential breaches of the IRR 2017.

5.7 Persons undertaking the monitoring should be competent to do so:

- a) Do they know how to operate the instrumentation? Have they received any relevant training to do so? Do they know how many readings / wipes to undertake (this is especially relevant on larger packagings)?
- b) Are they capable of interpreting the results of any measurements taken?
- c) Do they know the applicable limits for radiation, contamination and transport index?
- d) What is the evidence for these and are they adequate?

5.8 Are operators adequately trained to ensure that the wipe samples are obtained in a consistent manner?

- a) How are they trained and by whom?
- b) Is the training recorded? Is it refreshed?
- c) Do they follow an operating procedure which sets out the sampling regime? If not, how do they ensure consistency?

**Radiation and Contamination Monitoring of Packages, Overpacks, Containers, Unpackaged LSA-1 or SCO-1**

- 5.9 How does the duty holder ensure that, except for packages or overpacks carried under exclusive use, the maximum radiation level at any point on the external surface of a package or overpack does not exceed 2 mSv/h?
- 5.10 How does the duty holder ensure that the maximum radiation level at any point on the external surface of a package or overpack under exclusive use does not exceed those specified in ADR / RID 4.1.9.1.12 and 7.5.11 CV33 / CW33 (3.5)?
- 5.11 Does the duty holder meet the requirements for exclusive use when utilising these higher limits?
- 5.12 How does the duty holder ensure that non-fixed contamination on the external surfaces of any package is kept as low as (reasonably) practicable, and does not exceed 4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters and 0.4 Bq/cm<sup>2</sup> for all other alpha emitters?
- 5.12.1 It would be appropriate for checks to be made to ensure that any build-up does not occur in areas where packages are regularly handled. Similarly, it is advisable to check gloves or other items of clothing of personnel routinely handling packages.
- 5.12.2 How does the duty holder prevent surfaces from becoming contaminated in the first place?
- 5.13 How does the duty holder ensure that containers, tanks, IBCs, as well as other packagings and overpacks, used for the carriage of radioactive material are not being used for the storage or carriage of other goods unless decontaminated below the level of 0.4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters and 0.04 Bq/cm<sup>2</sup> for all other alpha emitters?
- a) Do they identify packagings and overpacks that cannot store or carry other goods?
- b) By what means is this achieved (segregation, administrative techniques, etc.) and are they adequate?
- 5.14 A container, tank, or IBC dedicated to the carriage of unpackaged radioactive material under exclusive use shall be excepted from the requirements for decontamination and in ADR / RID 4.1.9.1.4 solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use. How does the duty holder assess whether containers, tanks, IBCs or conveyances are transported under exclusive use?
- a) How does the duty holder ensure that such containers, tanks, IBCs or conveyances remain under that specific exclusive use?
- b) By what means is this achieved (segregation, administrative techniques, etc.) and are they adequate?
- c) Are the external surfaces of a freight container, tank, IBC under exclusive use being decontaminated to below applicable limits after each use?



- 5.15 It is ONR's expectation that a system of radiation monitoring, and contamination monitoring of external surfaces, will exist for each package, overpack, container, unpackaged LSA-1, or unpackaged SCO-1 every time they are consigned and / or received using appropriate instrumentation, unless excepted by ADR / RID or an adequate written justification of alternative arrangements. It would be appropriate for the adequacy of such arrangements to be reviewed at a suitable period, using a proportionate and graded approach, or after events / incidents, or when systems / practices change, and at least annually. It would also be appropriate for a record of the justification, and the results of subsequent reviews, to be made and retained for at least 5 years, in line with the DGSA reporting requirements. Any alternative arrangements must comply with the requirements of CDG 2009, and hence also ADR / RID. Checks should consider whether:
- a) the duty holder undertakes radiation and contamination monitoring for each package, overpack, container, unpackaged LSA-1, or unpackaged SCO-1 every time they are consigned, unless excepted by ADR / RID;
  - b) instrumentation is designed and appropriate for the intended purpose. For example, an EPD is not suitable for measuring package radiation levels.
- 5.16 For routine consignments of identical radioactive material(s), of identical activity values (i.e. A1 / A2), in identical packagings and consigned from one premises, alternative radiation and contamination monitoring arrangements may be acceptable. It would be appropriate for an adequate written justification of the suitability of such arrangements to be made, and reviewed at a suitable period, using a proportionate and graded approach, or after events / incidents, or when systems / practices change, and at least annually. It would also be appropriate for a record of the justification and the results of subsequent reviews to be made and retained for at least 5 years, in line with the DGSA reporting requirements. Any alternative arrangements must comply with the requirements of CDG 2009, and hence also ADR / RID. Any alternative arrangements must comply with the requirements of CDG 2009, and hence also ADR / RID. Examples include:
- 5.16.1 A special form gamma source in suitable packaging (a projection-type container) is transported to site each evening for a week to carry out site radiography. Radiation levels associated with this source are not likely to vary appreciably over the week considering the properties of the radioactive material involved. Routine confirmation of radiation levels around the package is appropriate to ensure the source has returned safely to its fully shielded position in the container ahead of transporting the package back to base.
- 5.16.2 A radiopharmaceutical manufactured to a standard specification (i.e. specified radioisotope(s), specified activity, etc.) packed in a specific packaging and routinely consigned from a medical production facility. In this case it may be acceptable to measure the radiation level(s) for such a configuration and, provided that the radiation level is unlikely to alter from consignment to consignment, then this 'previously measured' radiation level may be quoted for future consignments of this specific configuration. The 'previously measured' radiation level must be reviewed at

a suitable period, or after events / incidents, or when systems / practices change, and at least annually.

- 5.16.3 A radiopharmacy prepares patient 'nuclear medicine' doses which are transported in a 'Type A' package to a nuclear medicine department in a hospital located a few miles away. Contamination monitoring of external surfaces of the package will be required on each occasion the package is consigned. This may be evidenced by monitoring undertaken as part of the process to transfer material from the production area of a facility to the dispatch area provided the dispatch area is demonstrably 'clean'. On a return journey, a package is likely to be 'empty' however contamination monitoring may still be required considering a range of factors including the working environment that the package has been used and kept in.
- 5.16.4 A nuclear density gauge, incorporating two special form sources, which is transported on a daily basis for three weeks during a road construction project. Checks for package contamination are not routinely required considering the nature of the sources being carried and the working environment. Radiation levels around a package are not likely to vary appreciably over the course of the project considering the half-lives of these sources. Confirmation of the transport index ahead of transport at the beginning of the project would suffice in terms of radiation monitoring.
- 5.17 When a freight container, tank, intermediate bulk container is used to transport packages of radioactive material, the requirements for non-fixed contamination and decontamination limits in ADR / RID apply in order to avoid contamination of packages by the internal surface contamination of the freight container, tank, intermediate bulk container or conveyance. It would be appropriate to consider the likelihood of contamination by environmental conditions. For example, NDT source packages being used in areas where open sources of radioactive material are also used, or special form sources are used in laboratories where liquid radioactive materials are also used. This contamination may deposit on the package whilst in use and then be transferred to the conveyance and / or other packages.

### **Radiation and Contamination Monitoring of Damaged or Leaking Packages, and Contaminated Packages**

- 5.18 If it is evident that a package is damaged or leaking, or if it is suspected that the package may have leaked or been damaged:
- a) Do contingency arrangements exist for dealing with such situations? These should be detailed in the emergency arrangements (i.e. a plan in writing).
    - If not, assess adequacy of the emergency arrangements (plan in writing) using the relevant ONR Technical Inspection Guide, and also inform ONR or HSE RP specialist inspectors and / or HSE IRR inspectors regarding the potential breach of the IRR 2017.
  - b) Leaks or damage may be determined through, for example:
    - General changes in package appearance (dents, creasing, misshaped);

- Staining of surfaces
  - Corrosion
- c) Should access to the package be restricted? It would be appropriate for this requirement, and the means of achieving it, to be detailed in the emergency arrangements (plan in writing).
- d) The carrier must, as soon as is reasonably practicable, arrange for the examination of the load so as to determine whether contamination has arisen, and if it has, arrange for the safe disposal of any part of the load that has been contaminated and for the decontamination of the transport unit or train.
- Where will the assessment take place?
  - Will it be done remotely using video / photographs etc., at the roadside, or is provision made for removal to an acceptable interim location under supervision?
  - Who will authorise such a transfer, and how? Will it be the DGSA, consignor's agent, and/or another role?
- e) A package that has been involved in a radiological emergency must not be carried or caused to be carried unless the consignor or the consignor's agent has examined it and the consignor is satisfied that it complies with the requirements of CDG and has issued a certificate to that effect.
- How will the consignor or consignor's agent undertake such an examination? Will it be done remotely (using video / photographs etc.), or at the roadside?
  - Who will authorise such a certificate? Has a person been identified within the consigning organisation to undertake this function?
- f) Are there adequate provisions for a qualified person to assess the extent of contamination and the resultant radiation level of the package as soon as reasonably practicable?
- g) Does the scope of the assessment include the package, the conveyance, the adjacent loading and unloading areas, and, if necessary, all other material which has been carried in the conveyance?

5.18.1 The prime purpose of inspection by a qualified person is to assess whether leakage or loss of shielding integrity has occurred or could be expected to occur, and either give assurance that the package is safe and within the limits prescribed in the regulations or, if this is not the case, assess the extent of the damage or leakage and the radiological implications.

- a) Who would be the 'qualified person(s)' and how is their competency to undertake the assessment demonstrated?

- b) What are the arrangements for undertaking such an assessment, and do they consider the limits prescribed in the regulations?
- 5.19 What are the arrangements for packages damaged or leaking radioactive contents in excess of allowable limits for normal conditions of carriage?
- a) The arrangements should consider packages discovered or suspected to be damaged or leaking whilst being filled, packed, loaded, unloaded and during carriage.
- b) Are these set out in the duty holder's emergency arrangements (plan in writing)?
- Any inspection of a duty holder's emergency arrangements should be undertaken in conjunction with the Nuclear Safety Technical Inspection Guide NS-INSP-GD-066.
- c) How will packages be repaired or reconditioned and decontaminated prior to being forwarded? This may not be a detailed plan if the consignor, for example, consigns numerous forms of radioactive materials and / or in several types of packagings, as each case may vary considerably. Considerations may include the use of salvage packagings / overpacks to transport damaged / leaking packages, arrangements for additional shielding to be utilised, locations where damaged / leaking packages can be transported to for recovery and / or repair, arrangements to seek advice from the duty holder's DGSA (e.g. with competent authority approvals for onward consignment where necessary), and the availability of staff (employees and contractors) to provide logistical assistance in the recovery of a damaged / leaking package, etc.
- d) Are the arrangements adequate? Do they prevent further leakage and spread of radioactive material? Do they ensure that advice and approvals are obtained, where necessary?
- 5.20 On rare occasions, it may be necessary to extend surveys and investigations back along the route, the conveyances and the handling facilities to identify and clean up any contaminated areas. Investigations may need to include the assessment of external dose and possible radioactive intake by transport workers and members of the public.
- 5.21 What are the arrangements for conveyances containing damaged packages which appear to be leaking, or appear to be damaged?
- a) How are they to be detained and secured until they have been declared safe by a qualified person?
- b) Are the arrangements adequate?

### **Radiation and Contamination Monitoring of Conveyances**

- 5.22 How does the duty holder ensure that the **radiation** level under routine conditions of carriage does not exceed 2 mSv/h at any point on, and 0.1 mSv/h at 2 m from, the

external surface of the conveyance, except for consignments carried under exclusive use?

- 5.23 How does the duty holder ensure that for consignments carried under exclusive use the radiation limits around the conveyance do not exceed those specified in ADR / RID 4.1.9.1.12 and 7.5.11 CV33 / CW33 (3.5)(a)?
- 5.24 A conveyance and equipment used regularly for the carriage of radioactive material shall be periodically checked to determine the level of contamination. The frequency of such checks shall be related to the likelihood of contamination and the extent to which radioactive material is carried. Where the 'used regularly' criteria is met, and ONR interprets this to mean more than once or twice per month, the regulations provide some latitude in assigning a suitable monitoring frequency commensurate with the likelihood of contamination and transport frequency. The objective of this provision is to introduce a control mechanism to identify the presence of contamination and minimise its' spread. It is ONR's view that it is appropriate to consider whether the duty holders' transport operations could reasonably foreseeably give rise to vehicle and equipment contamination which can be identified by periodic monitoring, and factor this in alongside the frequency with which radioactive material is transported. Examples include:
- 5.24.1 A vehicle is used on a weekly basis to carry only Special Form (SF) radioactive material between places/premises that do not pose a reasonably foreseeable contamination risk. The sources are unlikely to give rise to contamination unless they were damaged. The duty holder has evidence that the continued source integrity is kept under review, and the sources have not been involved in any incidents or events, nor have they been subjected to harsh environmental conditions. As such they may be subject to a less frequent monitoring regime and an annual vehicle monitoring would not be unreasonable in these circumstances. If a duty holder was to conclude that contamination monitoring of vehicles was unnecessary, they should be prepared to substantiate this approach.
- 5.24.2 Where vehicles are used to transport liquid radiopharmaceuticals on a daily basis, for instance, these would reasonably require frequent monitoring due to the potential for contamination of these packages. An appropriate monitoring frequency could be monthly where routine package monitoring also takes place.
- 5.24.3 A carrier transports large unpackaged items that have naturally occurring radioactive material present on surfaces. They do this according to client demand, which can vary, but experience indicates this typically happens ten times a month. In these circumstances, ONR's view is that undertaking quarterly contamination monitoring is an appropriate approach.
- 5.25 Has an adequate assessment been undertaken to determine the periodicity of such checks? Considerations could include, but not necessarily be limited to, the following:
- a) The frequency of carriage.
  - b) The types of radioactive materials being carried.

- c) The form of the materials being carried – are they liquids, special form material, sealed sources, unpackaged materials etc.?
- d) The contamination potential of such materials.
- e) The amount of radioactive material carried – activity (Bq) and / or specific activity levels.
- f) Whether the conveyance is dedicated to the carriage of unpackaged radioactive material under exclusive use.

5.26 Are adequate arrangements in place to ensure that a conveyance, or equipment or part thereof which has become contaminated or shows a radiation level in excess of 5  $\mu\text{Sv/h}$  at the surface, shall be decontaminated as soon as reasonably practicable by a qualified person and shall not be re-used unless the following conditions are fulfilled:

- a) the non-fixed contamination shall not exceed the limits specified in ADR / RID 4.1.9.1.2;
- b) the radiation level resulting from the fixed contamination shall not exceed 5  $\mu\text{Sv/h}$  at the surface?
- Are the duty holder's arrangements for decontamination of a conveyance, or equipment or part thereof which has become contaminated adequate?

5.27 A conveyance dedicated to the carriage of unpackaged radioactive material under exclusive use shall be excepted from the requirements for decontamination and in solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use.

- a) How does the duty holder ensure that such containers, tanks, IBCs or conveyances remain under that specific exclusive use?
- b) By what means is this achieved (segregation, administrative techniques, etc.)?

5.28 The external surfaces which are continually being exposed to the environment, and which are generally much easier to decontaminate, should be decontaminated to below the applicable limits after each use.

- a) Does the duty holder monitor and decontamination these surfaces after each use?
- b) Are the arrangements adequate?

### **Determination of Transport Index (TI)**

5.29 Is the TI for a package, overpack, container, or for unpackaged LSA-1 or SCO-1 derived in accordance with the following?

- (a) Determine the maximum radiation level (in  $\text{mSv/h}$ ) at 1m from the external surface of the package, overpack or container, or for unpackaged LSA-1 or SCO-

1. The value determined shall be multiplied by 100 and the resulting number is the transport index.
- (b) For uranium and thorium ores and their concentrates, are the maximum radiation level at any point 1 m from the external surface of the load taken as; 0.4 mSv/h for ores and physical concentrates of uranium and thorium; 0.3 mSv/h for chemical concentrates of thorium; 0.02 mSv/h for chemical concentrates of uranium, other than uranium hexafluoride?
- (c) Are appropriate multiplication factors from ADR / RID Table 5.1.5.3.1 used for tanks, containers and unpackaged LSA-1 and SCO-1? A multiplication factor according to the size of the load should be applied in order to define the TI. The size of the load will normally be taken as the maximum cross-sectional area of the tank, freight container or conveyance, but where its actual maximum area is known, this may be used, provided that it will not change during transport. Is the value rounded up to the first decimal place, except that a value of 0.05 or less may be considered as zero?
- 5.30 Is the TI of a package determined on the basis of measured radiation levels, considering the package in isolation?
- 5.31 If the measured radiation level comprises more than one type of radiation, is the TI based on the sum of all the radiation levels from each type of radiation?
- 5.32 Is the TI determined by scanning all the surfaces of a package, including the top and bottom, at a distance of 1 m? How does the duty holder ensure that conventional health and safety risks are adequately addressed when doing so?
- 5.33 Similarly, the TI for a tank, a freight container and unpackaged LSA-I material and SCO-I is determined by measurement at 1 m from the surfaces, but a multiplication factor according to the size of the load should be applied in order to define the TI. The size of the load will normally be taken as the maximum cross-sectional area of the tank, freight container or conveyance, but where its actual maximum area is known, this may be used, provided that it will not change during transport.
- Does the duty holder have adequate arrangements for this?
- 5.34 How does the duty holder ensure that they obtain the highest value when determining the TI?
- 5.35 Where there are protrusions on the exterior surface, are such protrusions ignored in determining the 1 m distance, except in the case of a finned package, in which case the measurement may be made at 1 m distance from the external envelope of the package?
- 5.36 For routine consignments of identical radioactive material(s), of identical activity values (i.e. A1 / A2), in identical packagings and consigned from one premises, alternative radiation monitoring arrangements may be acceptable for determining the highest radiation value at 1 m in order to determine the TI for such consignments. It would be appropriate for an adequate written justification of the suitability of such arrangements to be made, and reviewed at a suitable period, using a proportionate



and graded approach, or after events / incidents, or when systems / practices change, and at least annually. It would also be appropriate for a record of the justification and the results of subsequent reviews to be made and retained for at least 5 years, in line with the DGSA reporting requirements. Any alternative arrangements must comply with the requirements of CDG 2009.

- 5.36.1 An example could be where the radiation level at 1 m has been 'previously measured' for a specific configuration similar to that detailed in 5.16.1 of this guide. This 'previously measured' level might then be used to determine the TI and may be quoted for future consignments of this specific configuration. It would be appropriate for the 'previously measured' radiation level at 1 m to be reviewed at a suitable period, or after events / incidents, or when systems / practices change, and at least annually.
- 5.37 Does the duty holder determine the TI for each overpack, container or conveyance as either:
- (a) the sum of the TIs of all the packages contained, or
  - (b) by direct measurement of radiation level, except in the case of non-rigid overpacks for which the transport index shall be determined only as the sum of the TIs of all the packages?
- 5.38 How does the duty holder ensure that, except for consignments under exclusive use, the transport index of any package or overpack does not exceed 10?
- 5.39 How does the duty holder ensure that, except under the condition of exclusive use, and for consignments of LSA-I material, the total number of packages, overpacks and containers aboard a single conveyance shall be so limited that the total sum of the transport indexes aboard the conveyance does not exceed 50?

### **Determination of Adequacy / Making a Judgement**

- 5.40 It is for inspectors to apply their experience and discretion to determine the extent and depth of a particular inspection, taking due account of a number of factors such as safety significance, complexity and technical specialism.
- 5.41 In determining adequacy, the ONR Inspection Rating Guide should be used by inspectors. This can be found on HOW2.
- 5.42 Where inspection indicates that a duty holder's arrangements fall significantly short of CDG 2009 requirements, and especially where enforcement action appears to be warranted under the Enforcement Management Model, (EMM) and more specifically NS-ENF-GD-002 – The Use of The Enforcement Management Model in ONR and associated guides, the inspector should seek advice from the ONR Delivery Lead and Professional Lead.

## **6. FURTHER READING**



- 6.1 IAEA Specific Safety Requirements No. SSR-6 Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition). See link: <http://www-pub.iaea.org/MTCD/publications/PDF/Pub1586web-99435183.pdf>
- 6.2 IAEA Specific Safety Guide No. SSG-26 Advisory material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition). See link: [http://www-pub.iaea.org/MTCD/publications/PDF/Pub1570\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/Pub1570_web.pdf)
- 6.3 IAEA Safety Guide No. TS-G-1.3 Radiation Protection Programmes for the Transport of Radioactive Material. See link: [http://www-pub.iaea.org/MTCD/publications/pdf/pub1269\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/pdf/pub1269_web.pdf)
- 6.4 IAEA Safety Guide No. TS-G-1.5 Compliance Assurance for the Safe Transport of Radioactive Material. See link: [http://www-pub.iaea.org/MTCD/publications/pdf/pub1361\\_web.pdf](http://www-pub.iaea.org/MTCD/publications/pdf/pub1361_web.pdf)
- 6.5 ONR's transport of radioactive materials webpages. See link: <http://www.onr.org.uk/transport/index.htm>
- 6.6 The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations 2011. See link: <http://www.legislation.gov.uk/ukxi/2011/1885/contents/made>
- 6.7 ONR Guide NS-INSP-GD-066: The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 – Plan in Writing: Emergency Arrangements. See link: [http://www.onr.org.uk/operational/tech\\_insp\\_guides/ns-insp-gd-066.pdf](http://www.onr.org.uk/operational/tech_insp_guides/ns-insp-gd-066.pdf)
- 6.8 NPL Good Practice Guide No. 30. See Link: [http://publications.npl.co.uk/npl\\_web/pdf/mgpg30.pdf](http://publications.npl.co.uk/npl_web/pdf/mgpg30.pdf)
- 6.9 HSE Information Sheet 'Selection, Use and Maintenance of Portable Monitoring Instruments'. See link: <http://www.hse.gov.uk/pubns/irp7.pdf>

**7. DEFINITIONS**

ADN	European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterway
ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
CDG 2009	The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009
CDG 2011	The Carriage of Dangerous Goods and Use of Transportable

## Pressure Equipment (Amendment) Regulations 2011

Class 7	The dangerous goods classification for radioactive materials
Competent Authority (ADR)	The authority or authorities or any other body or bodies designated as such in each State and in each specific case in accordance with domestic law
Conveyance	Means, for carriage by road or by rail, a vehicle or a wagon
COTIF	Convention Concerning International Carriage by Rail
Exclusive Use	For the carriage of radioactive material, means the sole use, by a single consignor, of a conveyance or of a large container, in respect of which all initial, intermediate & final loading & unloading & shipment are carried out in accordance with the directions of the consignor or consignee, where so required by ADR
IAEA	International Atomic Energy Agency
IBC	Intermediate Bulk Container
IIS	ONR's Integrated Intervention Strategy
LSA	Low Specific Activity material means radioactive material which by its nature has a limited specific activity, or radioactive material for which limits of estimated average specific activity apply. External shielding materials surrounding the LSA material shall not be considered in determining the estimated average specific activity.
ONR	Office for Nuclear Regulation
Radioactive Material	Means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in ADR / RID 2.2.7.2.2.1 to 2.2.7.2.2.6.
Radiological Emergency (under CDG)	A situation arising during the course of the carriage of a consignment that requires urgent action in order to protect workers, members of the public or the population (either partially or as a whole) from exposure.
RGP	Relevant Good Practice

RID	Regulations Concerning the International Carriage of Dangerous Goods by Rail
RPP	Radiation Protection Programme
SCO	Surface contaminated object (SCO) means a solid object which is not itself radioactive but which has radioactive material distributed on its surface.
Special Form	Special form radioactive material means either: (a) An indispersible solid radioactive material; or (b) A sealed capsule containing radioactive material.
UNECE	United Nations Economic Commission for Europe.

## **ANNEX A - GUIDANCE ON ARRANGEMENTS FOR RADIATION AND CONTAMINATION MONITORING, AND SUBSEQUENT DETERMINATION OF TRANSPORT INDEX FOR ADR / RID (VIA CDG 2009)**

### **General**

- A.1 The duty holder must have arrangements in place to demonstrate compliance with the Regulations. These arrangements must be implemented adequately. This section considers aspects of the requirement for contamination and radiation monitoring, and subsequent determination of transport index. It is neither exclusive nor exhaustive and will be subject to review and revision in the light of operational experience. If duty holders have generic models for such arrangements then it is for the duty holder to justify any deviation from the models. Any such deviations must comply with the requirements of CDG 2009, and hence also ADR / RID.
- A.2 The purpose of such monitoring, and subsequent determination of transport index is to protect the workers, members of the public or the population from exposure to ionising radiation so far as is reasonably practicable.
- A.3 Relevant procedures should be readily available and should be up to date, authorised and be controlled documents. The person responsible for compliance should be identified within the management system arrangements.
- A.4 Package radiation levels should be clearly defined and expressed as the corresponding dose rate in millisievert per hour (mSv/h) or microsievert per hour ( $\mu$ Sv/h).
- A.5 The transport index, assigned to a package, overpack or container, or to unpackaged LSA-1 (low specific activity) or SCO-1 (surface contaminated object), is defined as a number [based upon associated radiation levels and load size] which is used to provide control over radiation exposure.
- A.6 Contamination is defined as the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters, or 0.04 Bq/cm<sup>2</sup> for all other alpha emitters. Non-fixed contamination means contamination that can be removed from a surface during routine conditions of carriage. Fixed contamination means contamination other than non-fixed contamination.
- A.7 Low toxicity alpha emitters are defined as natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; or alpha emitters with a half-life of less than 10 days.
- A.8 Except as provided in ADR / RID 7.5.11, CV33 / CW33, the level of non-fixed contamination on the external and internal surfaces of overpacks, containers, tanks, IBCs and conveyances shall not exceed the following limits: (a) 4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters; and (b) 0.4 Bq/cm<sup>2</sup> for all other alpha emitters. These limits are applicable when averaged over any area of 300 cm<sup>2</sup> of any part of the surface.

- A.9 Contamination levels on the external surfaces of packages should be kept as low as practicable. The most effective way to ensure this is to prevent the surfaces from becoming contaminated. Loading, unloading and handling methods should be kept under review to achieve this.
- A.10 The instrumentation to be used to measure the radiation levels and / or contamination levels of the package, the overpack, the freight container, or conveyance etc. should be selected to be sensitive to, and calibrated for, the type of radiation to be measured. It should be reliable, functioning correctly, in good condition, maintained and tested according to the manufacturer's instructions. Persons undertaking the monitoring should be competent to do so. In the case of a leaking, damaged or contaminated package a qualified person must assess the contamination and radiation level.
- A.10.1. When monitoring finned flasks or other transport packages care ought to be taken where narrow radiation beams may be encountered and an appropriate instrument chosen for the work.
- A.10.2. In a few cases, measurement of contamination may be made by direct reading of contamination monitors. Such a measurement will include both fixed and non-fixed contamination. Interference may also occur from gamma fields.
- A.10.3. The level of non-fixed contamination may be determined by wiping an area of 300 cm<sup>2</sup>. It would be appropriate for the number of wipe samples taken on a larger package to be such as to be representative of the whole surface and ought be chosen to include areas known or expected to be more contaminated than the remainder of the surface.
- A.10.4. It would be appropriate for users to develop specific contamination measurement techniques relevant to their particular circumstances. Such techniques include the use of wipes and appropriate survey instruments. The instruments and detectors selected ought to take into account the radionuclides to be measured.
- A.10.5. Operators should be competent to ensure that the wipe samples are obtained in a consistent manner.

### **Radiation and Contamination Monitoring of Packages, Overpacks, Containers, Unpackaged LSA-1 or SCO-1**

- A.11 Except for packages or overpacks carried under exclusive use under the conditions specified in ADR / RID 7.5.11, CV33 / CW33 (3.5)(a), the maximum radiation level at any point on the external surface of a package or overpack shall not exceed 2 mSv/h.
- A.12 The maximum radiation level at any point on the external surface of a package or overpack under exclusive use shall not exceed 10 mSv/h and may only exceed 2 mSv/h provided that:
- the conveyance is equipped with an enclosure which, during routine conditions of carriage, prevents the access of unauthorised persons to the interior of the enclosure;

- provisions are made to secure the package or overpack so that its position within the conveyance enclosure remains fixed during routine conditions of carriage, and;
  - there is no loading or unloading during the shipment.
- A.13 The non-fixed contamination on the external surfaces of any package shall be kept as low as practicable and, under routine conditions of transport, shall not exceed the following limits: (a) 4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters; and (b) 0.4 Bq/cm<sup>2</sup> for all other alpha emitters. These limits are applicable when averaged over any area of 300 cm<sup>2</sup> of any part of the surface.
- A.14 Containers, tanks, IBCs, as well as other packagings and overpacks, used for the carriage of radioactive material shall not be used for the storage or carriage of other goods unless decontaminated below the level of 0.4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters and 0.04 Bq/cm<sup>2</sup> for all other alpha emitters.
- A.15 A container, tank or intermediate bulk container dedicated to the carriage of unpackaged radioactive material under exclusive use shall be excepted from the requirements of [5.4 of CV33 / CW33], and in ADR / RID 4.1.9.1.4 solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use. Therefore it would be appropriate for the external surfaces of a freight container, tank or intermediate bulk container which are continually being exposed to the environment, and which are generally much easier to decontaminate, to be decontaminated to below the applicable limits after each use.
- A.16 When a freight container, tank or intermediate bulk container is used to transport packages of radioactive material, the requirements for non-fixed contamination limits and decontamination limits in ADR / RID apply in order to avoid contamination of packages by the internal surface contamination of the freight container, tank or intermediate bulk container.
- A.17 It is ONR's expectation that the consignor has the primary responsibility for ensuring that radiation and contamination levels of packages are in accordance with the regulatory requirements. However, consignors, carriers and consignees will all have some responsibilities in respect of package, conveyance, workplace and individual monitoring, depending on their individual circumstances.
- A.18 It is ONR's expectation that a system of radiation monitoring, and contamination monitoring of external surfaces, will exist for each package, overpack, container, unpackaged LSA-1, or unpackaged SCO-1 every time they are consigned and / or received using appropriate instrumentation, unless excepted by ADR / RID or an adequate written justification of alternative arrangements.
- A.19 For routine consignments of identical radioactive material(s), of identical activity values (i.e. A1 / A2), in identical packagings and consigned from one premises, alternative radiation monitoring arrangements may be acceptable.

### **Radiation and Contamination Monitoring of Damaged or Leaking Packages, and Contaminated Packages**

- A.20 A package that has been involved in a radiological emergency must not be carried or caused to be carried unless the consignor or the consignor's agent has examined it and the consignor is satisfied that it complies with the requirements of CDG and has issued a certificate to that effect.
- A.21 If it is evident that a package is damaged or leaking, or if it is suspected that the package may have leaked or been damaged, access to the package shall be restricted and a qualified person shall, as soon as [reasonably practicable], assess the extent of contamination and the resultant radiation level of the package. The scope of the assessment shall include the package, the conveyance, the adjacent loading and unloading areas, and, if necessary, all other material which has been carried in the conveyance. When necessary, additional steps for the protection of persons property and the environment, in accordance with provisions established by the competent authority, shall be taken to overcome and minimise the consequences of such leakage or damage.
- A.21.1. The prime purpose of inspection by a qualified person is to assess whether leakage or loss of shielding integrity has occurred or could be expected to occur, and either give assurance that the package is safe and within the limits prescribed in the regulations or, if this is not the case, assess the extent of the damage or leakage and the radiological implications. On rare occasions, it may be necessary to extend surveys and investigations back along the route, the conveyances and the handling facilities to identify and clean up any contaminated areas. Investigations may need to include the assessment of external dose and possible radioactive intake by transport workers and members of the public.
- A.21.2. Packages damaged or leaking radioactive contents in excess of allowable limits for normal conditions of carriage may be removed to an acceptable interim location under supervision, but shall not be forwarded until repaired or reconditioned and decontaminated.
- A.21.3. Conveyances containing damaged packages which appear to be leaking, or appear to be severely dented or breached, should be detained and secured until they have been declared safe by a qualified person.

### **Radiation and Contamination Monitoring of Conveyances**

- A.22 The radiation level under routine conditions of carriage shall not exceed 2 mSv/h at any point on, and 0.1 mSv/h at 2 m from, the external surface of the conveyance, except for consignments carried under exclusive use.
- A.23 For consignments carried under exclusive use the radiation limits around the conveyance are:
- 2 mSv/h at any point on the outer surfaces of the conveyance, including the upper and lower surfaces, or, in the case of an open conveyance, at any point on the vertical planes projected from the outer edges of the conveyance, on the upper surface of the load, and on the lower external surface of the conveyance; and;

- 0.1 mSv/h at any point 2 m from the vertical planes represented by the outer lateral surfaces of the conveyance, or, if the load is carried in an open conveyance, at any point 2 m from the vertical planes projected from the outer edges of the conveyance.
- A.24 A conveyance and equipment used regularly for the carriage of radioactive material shall be periodically checked to determine the level of contamination [to avoid contamination of packages by internal surface contamination of the conveyance]. The frequency of such checks shall be related to the likelihood of contamination and the extent to which radioactive material is carried.
- A.25 ONR's interpretation of 'used regularly', as applied to paragraph A.24, is when the occurrence of use is repeated, constant or frequent. Therefore, if a conveyance is used to carry radioactive materials regularly (i.e. more than once or twice per month) then the periodic checks required in A.24 should to be undertaken.
- A.26 Except as provided in paragraph (5.5) [of CV33 / CW33], any conveyance (internally or externally), or equipment or part thereof which has become contaminated above the limits specified in ADR / RID 4.1.9.1.2 in the course of carriage of radioactive material, or which shows a radiation level in excess of 5  $\mu$ Sv/h at the surface, shall be decontaminated as soon as [reasonably practicable] by a qualified person and shall not be re-used unless the following conditions are fulfilled: (a) the non-fixed contamination shall not exceed the limits specified in ADR / RID 4.1.9.1.2; (b) the radiation level resulting from the fixed contamination shall not exceed 5  $\mu$ Sv/h at the surface.
- A.27 A conveyance dedicated to the carriage of unpackaged radioactive material under exclusive use shall be excepted from the requirements of [5.4 of CV33 / CW33], and in ADR / RID 4.1.9.1.4 solely with regard to its internal surfaces and only for as long as it remains under that specific exclusive use. Therefore it would be appropriate for the external surfaces of a conveyance which are continually being exposed to the environment, and which are generally much easier to decontaminate, to be decontaminated to below the applicable limits after each use.

### **Transport Index (TI)**

- A.28 The consignor should be able to demonstrate to the competent authority an appropriate way(s) to determine the transport index.
- A.29 Except for consignments under exclusive use, the transport index of any package or overpack shall not exceed 10.
- A.30 The transport index for a package, overpack or container, or for unpackaged LSA-1 or SCO-1 shall be derived in accordance with the following procedure:
- (a) Determine the maximum radiation level in units of millisievert per hour (mSv/h) at a distance of 1m from the external surface of the package, overpack or container, or for unpackaged LSA-1 or SCO-1. The value determined shall be multiplied by 100 and the resulting number is the transport index. For uranium and thorium



ores and their concentrates, the maximum radiation level at any point 1 m from the external surface of the load may be taken as:

0.4 mSv/h for ores and physical concentrates of uranium and thorium;

0.3 mSv/h for chemical concentrates of thorium;

0.02 mSv/h for chemical concentrates of uranium, other than uranium hexafluoride;

(b) For tanks, containers and unpackaged LSA-1 and SCO-1, the value determined in step (a) above shall be multiplied by the appropriate factor from ADR Table 5.1.5.3.1;

(c) The value obtained in steps (a) and (b) above shall be rounded up to the first decimal place (e.g. 1.13 becomes 1.2), except that a value of 0.05 or less may be considered as zero.

A.31 It would be appropriate for the TI of a package to be determined on the basis of measured radiation levels, considering the package in isolation and, if the measured dose rate (radiation level) comprises more than one type of radiation, then the TI ought to be based on the sum of all the dose rates (radiation levels) from each type of radiation.

A.32 The TI is determined by scanning (surveying) all the surfaces of a package, including the top and bottom, at a distance of 1 m. The highest value measured is the value that determines the TI. Similarly, the TI for a tank, a freight container and unpackaged LSA-I material and SCO-I is determined by measurement at 1 m from the surfaces, but a multiplication factor according to the size of the load should be applied in order to define the TI. The size of the load will normally be taken as the maximum cross-sectional area of the tank, freight container or conveyance, but where its actual maximum area is known, this may be used, provided that it will not change during transport.

A.33 It would be appropriate, where there are protrusions on the exterior surface, for the protrusion to be ignored in determining the 1 m distance, except in the case of a finned package, in which case the measurement may be made at 1 m distance from the external envelope of the package.

A.34 The transport index for each overpack, container or conveyance shall be determined as either the sum of the TIs of all the packages contained, or by direct measurement of radiation level, except in the case of non-rigid overpacks for which the transport index shall be determined only as the sum of the TIs of all the packages.

A.35 Except under the condition of exclusive use, and for consignments of LSA-I material, the total number of packages, overpacks and containers aboard a single conveyance shall be so limited that the total sum of the transport indexes aboard the conveyance does not exceed 50.

A.36 Any package or overpack having a transport index greater than 10 shall be carried only under exclusive use.