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UK Guidance on Radiation Protection Programmes for the Transport of Radioactive Material

The Radioactive Materials Transport Team produced the following document when they were based in the Department for Transport.

From 24 October 2011, responsibility for the regulation of the transport of radioactive material moved to the Office for Nuclear Regulation where the Radioactive Materials Transport Team is now located.

UK Guidance on Radiation Protection Programmes for the Transport of Radioactive Material

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Disclaimer

This document has been prepared by the NRPB based on a provisional safety guide produced by the International Atomic Energy Agency (IAEA). It is made available by the Department in the hope that it will be useful to the industry, but without the Department accepting responsibility for its contents. Interpretation of the legal requirements is a matter for the courts only

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1. INTRODUCTION

The IAEA draft provisional safety guide on Radiation Protection Programmes for the transport of radioactive materials has been used as the basis for this document.

1.1 New requirement.

One of the major new requirements in the UK transport regulations is that a Radiation Protection Programme (RPP) shall be established for the transport of radioactive material, and such programmes shall be available, on request, for inspection by the relevant Competent Authority. An RPP contains systematic arrangements that are aimed at providing adequate consideration of radiation protection measures.

This document is intended to provide UK guidance to users of transport regulations on where and how a Radiation Protection Programme can be established and implemented. Appendix 1 gives the section on Radiation Protection Programmes from The Radioactive Material (Road Transport) Regulations 2002 [1].

1.2 UK legislation.

In the UK there are separate but consistent regulations for the transport of radioactive materials by road, rail, sea and air. There are additional controls provided by general legislation such as the Ionising Radiations Regulations 1999 (IRRs) [2] and the Radioactive Substances Act 1993 [3].

For the transport of radioactive materials, the executive role of the Competent Authority is carried out by the Radioactive Materials Transport Division (RMTD) of the Department for Transport. Enforcement of modal regulations is by the Department for Transport, HM Railway Inspectorate, the Maritime and Coastguard Agency and the Civil Aviation Authority.

The Ionising Radiations Regulations 1999 give effect to the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation. The general provisions of these regulations apply to transport operations: they include requirements for control of exposure, Radiation Protection Advisers, training, assessments and notifications. The Health and Safety Executive is the enforcing authority.

The Radioactive Substances Act requires registration for the use of radioactive materials and authorisation for the disposal of radioactive materials. The Environment Agency administers and enforces the Act in England and Wales and in Scotland the relevant body is the Scottish Environment Protection Agency.

1.3 Fundamentals of radiation protection.

There are three basic radiation protection principles for practices, which may give rise

to exposure to radiation, they are:

- justification of a practice, i.e. no practice shall be adopted unless it produces a net benefit;
- limitation of dose and risk to individuals, i.e. exposure of individuals should be subject to dose and risk limits;
- optimisation of radiation protection and safety, i.e. all exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account (ALARA principle).

The ALARA principle is the driving force behind the establishment of a Radiation Protection Programme (RPP) for the transport of radioactive material.

The International Commission for Radiological Protection (ICRP) [4] stresses that:

> "Much can be achieved in optimisation of protection, particularly in everyday operational control, through the use of professional judgment by suitably qualified, experienced and competent persons. The following are suggested to help judge if an action is reasonable:
>
> (a) Common Sense: this reflects experience, knowledge and the exercise of professional judgement. For example, a very low cost yet practical change that reduces dose probably should be done even if doses are already low.
>
> (b) Good Practice; this compares what has been or is expected to be achieved with what has been achieved for similar or related facilities or practices. Care must be taken to ensure that reasonableness is maintained and that unwarranted expenditures do not become the norm."

In a paper on transport radiation controls and assessment [5] it is concluded that: "The control measures required for transport purposes cannot in themselves ensure that the exposures of workers or members of the public are as low as reasonably achievable. Periodic assessments and, where appropriate, individual monitoring must occur."

2. OBJECTIVES

RPPs are intended to provide and document in a systematic and structured way the framework of controls applied by a transport organisation to satisfy the radiation protection principles and provisions: in particular to limit both the normal and potential exposures of workers and members of the public.

The objectives of an RPP for the transport of radioactive material are to:

- provide for adequate consideration of radiation protection measures,
- ensure that the system of radiological protection is adequately applied,
- enhance the safety culture, and
- provide practical measures to meet these objectives.

An RPP may consist of one or several documents and may be a part of the operator's general QA programme.

The operational radiation protection objectives incorporated in a programme may be diverse in nature and may reflect, for example, regulatory, managerial or operational requirements and criteria concerning radiation protection in transport. The nature and extent of control measures to be employed in an RPP should be related to the magnitude and likelihood of radiation exposures, i.e. the control measures employed are expected to be commensurate to the level of hazards arising from radioactive material transport ('graded approach'). Radiation Protection Programmes (RPPs) cover all aspects of transport and associated conditions including routine transport conditions and transport and handling incidents and accidents.

This document does not address the criticality safety that may be necessary for packages containing fissile material. Its focus is entirely on the more general aspects of radiation protection. However packages containing fissile material will need additional considerations that are beyond the scope of this document.

3. NEED AND SCOPE FOR RPPs IN TRANSPORT

A Radiation Protection Programme (RPP) should cover all aspects of transport, but the main emphasis should be put on the stages of transport operations giving rise to exposure to radiation. For example packing, preparation, loading, handling, storage-in-transit and movement of radioactive material packages and maintenance of packagings.

The first step in establishing an RPP is to make a prior radiological evaluation of the situation. This involves a description of the type, nature and volume of radioactive material being shipped, the magnitude and likelihood of radiation exposures arising from these transport operations, the number of workers potentially involved and the duration of the operations involved and the distance to the RAM. This information will allow the operator to define the scope of the RPP.

RPPs define and document a systematic and structured way for the framework of controls to be applied by a transport organization with the prime aim to optimize protection and safety in the transport of radioactive material. It is generally recognized that optimisation of protection and safety of workers and the public is most effectively addressed at the early stage of transport related activities such as the design, manufacture, scheduling and preparation of the radioactive material packages. The implementation of this approach may not be satisfactory for a variety of transport conditions. In particular, for more complex shipping conditions which may involve many organization and transport related activities, there are transport related operations and related radiation protection considerations that are outside the scope of the radiation protection controls provided for by the designer of a package or manufacturer of packaging. An example would be the lack of safety culture of the carrier or consignor. Even if radiation protection and safety have been optimized at the pre-operational stage of a radioactive material shipment and priority is given to the package design and technical measures for controlling exposure to radiation, there is generally still a need for optimisation of radiation protection arrangements at the various stages of transport operations.

An RPP is required for the operational stages of loading, carriage, in-transit storage, intermodal transfer, unloading and delivery of radioactive material packages at the final destination and maintenance of unloaded packages (if contaminated or containing residual radioactivity). An RPP is therefore mainly concerned with the loading, carriage, handling, delivery and unloading procedures involved with the operations on packaged or unpackaged radioactive material by the consignor, carrier, in-transit storage and transfer point operator and consignee.

The radiation protection controls employed in an RPP for these operations may encompass a broad set of regulatory or technical safety requirements but should be commensurate to the magnitude and likelihood of radiation exposures being incurred. The controls should be reasonably related to the hazards arising from radioactive material transport and consequently a graded approach is applied as shown in Table 1. Small operations involving only a limited number of package shipments may require a short RPP while more significant operations with very diverse materials and packages being shipped and handled in the public domain need to have a more significant programme in place.

An RPP should cover all aspects of transport and associated conditions of transport including normal, routine and accident conditions of transport.

There are cases of a dedicated carrier or shipper organization contracted solely for transport operations of a specific consignor or consignee. The consignor/ consignee has a properly developed RPP in place and this may cover the carrier or shippers operations. In such circumstances the Competent Authority may not require the carrier or shipper to have a separate RPP solely for transport if all relevant radiation protection obligations are accounted for by the relevant consignor or consignee organization.

The principal radiation protection consideration to be accounted for in an RPP should, consistent with the programme structure outlined in Table 1, cover the following basic elements contributing to protection and safety. Each element should be documented with the appropriate level of detail:

- roles and responsibilities for the implementation of the programme,
- dose assessment and optimisation,
- surface contamination assessment,
- segregation and other protective measure,
- emergency response arrangements,
- training and information and quality assurance (QA).

The Radioactive Material (Road Transport) Regulations 2002 state the following:
"Every carrier, consignor and consignee must -

(a) at suitable intervals (not exceeding 3 years) review and, where necessary, revise the radiation protection programme as respects his employees, such review taking into account any changes that have occurred in the transport of radioactive material to which the programme relates as well as any advances in technical knowledge and any material change to the assessment on which the programme was based;

(b) upon a written request made to him by the secretary of state, make his radiation protection programme, or any revision of it, available to the Secretary of State."

4. BASIC ELEMENTS OF AN RPP AS A FUNCTION OF OCCUPATIONAL DOSE

The basic elements of an RPP are shown in the first column of Table 1, RPP elements versus occupational dose. Sections 3, and 5 to 11 of this document treat in more detail each of these basic elements.

TABLE 1. RPP ELEMENTS VERSUS OCCUPATIONAL DOSE

RPP Element	Occupational dose *		
	Not more than 1 mSv in a year.	More than 1 mSv in a year but not more than 6 mSv in a year	More than 6 mSv in a year
a) Scope	Yes		
b) Roles/Responsibilities	Yes		
c) Dose Assessment	No monitoring required	Workplace or individual monitoring	Individual monitoring mandatory
d) Dose Limits/Constraints/ Optimisation	Yes, but basic optimisation	Yes	
e) Surface Contamination	Must be considered		
f) Segregation** and other protective measures	Only applicable to II-YELLOW, III-YELLOW, III-YELLOW under exclusive use (and packages containing fissile material)		
g) Emergency Response **	Yes		
h) Training **	Yes		
i) Quality Assurance **	Yes		

* Note: A graded approach should be used as appropriate for each RPP element.
** Not only an RPP element, broader considerations may be involved. An RPP can, however, refer to elements existing elsewhere.

Different factors determine the importance of each of these basic elements of an RPP such as dose rate, A_1/A_2 content, number of packages transported annually or public access to packages.

Low occupational dose or occasional transport does not mean an RPP is not required; for instance transport of high activities in heavily shielded packages generally gives low doses but still requires thorough consideration of other basic elements such as emergency response and training.

Depending on the assessed effective dose for occupational exposures arising from transport activities, it is possible to apply a graded approach to the RPP element requirements, for example where it is assessed that the effective dose:

- is most unlikely to exceed 1 mSv in a year, very little action, apart from optimisation, needs to be taken in this dose range for evaluating and controlling worker doses,
- is likely to be between 1 and 6 mSv in a year, a dose assessment programme is necessary and can utilise work place monitoring or individual monitoring,

- is likely to exceed 6 mSv in a year, individual monitoring of the transport personnel is mandatory.

High external dose rates do not necessarily result in high doses. Operational procedures and other protective measures including segregation are important in such circumstances.

5. ASSIGNMENT OF THE ROLES AND RESPONSIBILITIES FOR THE ESTABLISHMENT OF A RADIATION PROTECTION PROGRAMME

The regulatory framework governing the safe transport of radioactive material assigns specific duties and responsibilities of compliance with certain objectives, requirements and procedures relevant to the safety and security to the transport organizations (operator) and Competent Authorities. These duties and responsibilities are briefly outlined below.

5.1 The Operator's Responsibilities

It is the principal responsibility of the transport organization, for example the consignor, carrier, port operator, consignee:

i) to identify and document the safety and performance objectives, and

ii) to provide the necessary organizational infrastructure and resources to ensure that the RPP objectives are achieved in compliance with all relevant regulatory and managerial requirements in an effective manner. The safety and performance objectives may reflect those of a transport organization or are promulgated by regulatory or standard setting bodies.

The safety objectives (or policy) and the management's commitment to optimize protection and safety should be clearly stated in the RPP by documentation, as should the management's commitment to provide the necessary resources and the budgetary support for the establishment, implementation and application of the RPP.

It is acknowledged that the radiation protection objectives being pursued by the implementation and application of the RPP are best established through the cooperation of the parties engaged in transport operations. In more complex transport operations this may be difficult to achieve. For example, a transboundary shipment of radioactive material by road, rail and sea may involve a great number of independent transport organizations. Such shipments could include road carriers, seaport operators, sea carriers and railway organizations where essentially each party undertakes work in its own right and under its own responsibility. Each of these transport organizations can, however, be held responsible for radiation protection arrangements only to the extent where they have direct responsibilities for compliance with prescribed legislative, regulatory, managerial or operational requirements concerning radiation protection. It would be considered unreasonable and impractical to assign the duty of the establishment and application of an RPP for transport operations to an organization or party (e.g. the consignor of a radioactive material) where the organization or party has no direct bearing on, nor any direct responsibility, for operational radiation protection considerations.

Hence the duty of implementation and application of a radiation protection programme rests essentially on each independently operating transport organization involved in the shipment of radioactive material. Co-operation is expected between carriers, consignors and consignees. Advantage may be taken of safety provisions provided under a regulatory regime other than transport thereby ensuring a commensurate standard of safety and protection including radiological protection. Application of this approach also prevents duplication of unnecessary effort and helps to avoid overlapping responsibilities.

The Competent Authority may require an alternative system to be implemented and applied, for example, by requiring the consignor to examine and evaluate the adequacy and effectiveness of the radiation protection programme of the subcontractors involved in transport activities of its own radioactive material shipments. Consignors may also decide to voluntarily assist subcontractors in the development of their RPPs.

It is also recognized that workers can by their action contribute to the protection and safety of themselves and others at work. They are also responsible for providing feedback on these matters to the management.

The nationally relevant legislative and regulatory framework for the safe transport of radioactive material generally assigns specific responsibilities of compliance with certain objectives, duties, requirements and procedures relevant to safety and security to the parties (operators) involved in the transport of radioactive material. Some of these duties and procedures may be developed by the transport organizations; others are required by regulatory or other standard-setting bodies.

Management is responsible for ensuring that exposures are limited, that protection and safety are optimized and that appropriate RPPs are established and implemented.

It is therefore the principal responsibility of the management of the transport organization (operator) that the safety objectives (goal setting) are documented and that the safety-related duties and responsibilities including the requirement for optimisation of protection are properly implemented. This can be achieved through the adoption of adequate management structures, policies and organizational arrangements that are commensurate with the anticipated transport operations and the associated nature and extent of the hazards.

The management structure should reflect the management's commitment to safety by written policy statements and by clear support for those with direct responsibility for radiation protection and safety in the workplace and the public domain. The organizational arrangements should clearly identify and document the roles and responsibilities of the individuals involved and the functions to be performed by them. They should also ensure that an adequate infrastructure and resources are available, i.e. providing, where relevant, facilities, suitably qualified staff, equipment, training, feedback mechanisms and the authoritative power to perform the activities in compliance with all relevant legislative, regulatory and managerial requirements and operational procedures in an effective manner. The individuals responsible for managing the RPP must be clearly designated, and given the authority necessary to implement the programme.

Preparation of the administrative and operational functions including the establishment and application of an RPP may be performed through a suitably qualified expert, for example a radiation protection adviser (RPA). However, the final responsibility for ensuring compliance with all relevant regulations, decrees, directives, ordinances and standards rests on the management of the transport organization.

At suitable intervals (not exceeding 3 years) every carrier, consignor and consignee must review and where necessary revise their RPP taking account of relevant operational changes and recent technical information.

5.2 Competent Authority Responsibilities

It is the principal role and responsibility of the Competent Authority to enforce compliance with all relevant requirements and standards including optimisation of protection and safety in transport. The elements addressed by the Competent Authority in reviewing an RPP may include the following:

To examine that:

- the RPP is documented and implemented and commensurate with the hazards of the transport programme of the organization/operator;
- optimisation of protection and safety is adequate and effectively implemented, (i.e. that all reasonable and practical steps have been taken to keep normal and potential exposures as low as reasonably achievable, economic and social factors being taken into account, for workers and members of the public);
- adequate training and information to workers is being provided;
- experience feedback mechanisms are in place; and
- formal arrangements for periodic reviews for the radiation protection issues are in place.

In addition the Competent Authority may, where appropriate arrange for periodic assessment of the radiation doses to persons due to the transport of radioactive material.

The programme documents should be available, on request, for inspection by the relevant Competent Authority.

6. DOSE ASSESSMENT AND OPTIMISATION

6.1 Dose Assessment Principles

Dose assessment and evaluation is a key issue within the framework of RPPs and relates to two fundamental radiation protection considerations:

- *A prior dose assessment and evaluation* for workers, and when required the public, to ensure at the pre-operational stage of transport that due account has been taken of all reasonably applicable radiation protection measures. It is also necessary for a graded approach for this dose assessment to be used. The purpose of the assessment is to describe, as precisely as necessary, the radiological impact that may be associated with transport operations involving radioactive material shipments It may, as appropriate, in particular cover the following:
  a) identification of the exposures and doses from routine and normal conditions of transport;
  b) provision, where required by the degree of hazard, of a reasonably accurate estimate of the expected dose to persons, and the frequency of occurrence of potential exposures.
- *Radiation monitoring and dose assessment* demonstrating compliance with all relevant radiation protection standards and criteria during transport, thereby establishing confidence in, and continuation of, good practice.

For the assessment and evaluation of the transport-related radiation dose the package type, package category, exposure, frequency of operation, and the transport volume all need to be considered. Specific handling procedures (for example small packages or packages that are remotely handled) should be taken into account.

6.1.1 Monitoring

Monitoring packages and conveyances

Routine monitoring made at the surface and at a certain distance from the packages and conveyances should be detailed in the RPP to ensure both the current regulatory limits for radiation levels and surface contamination are met and the scope of the RPP has been well defined. The nature and frequency of the monitoring should be specified, depending on the scope of the RPP. The equipment to be used should be suitable to the types of radiation encountered and calibrated to meet the appropriate performance standards.

Monitoring workplaces

Routine monitoring made in the environment of the worker can be associated with continuing operations both to demonstrate that the working conditions remain satisfactory and to meet regulatory requirements. Additionally, the results of the monitoring may be used for dose assessment. These measurements can be conducted in the storage buildings as well as in vehicles, airplanes, and ships. They comprise monitoring for external radiation and surface contamination. The nature and frequency of the workplace monitoring should result from the prior radiological evaluation.

The equipment to be used should be suitable to the types of radiation encountered and calibrated to meet the appropriate performance standards. It is important to select the best location for the workplace monitoring.

Monitoring workers

When necessary, an individual monitoring programme will be a detailed part of the RPP. It will allow a value to be assigned to external and/or internal exposure to an individual. It can be based either on equipment worn by individual workers, such as dosemeters for external irradiation or on other measurements and calculation.

This monitoring assists in achieving compliance with the radiation protection principles of limitation and optimisation.

The equipment to be used should be suitable to the types of radiation encountered and calibrated to meet the appropriate performance standards.

Recording and reporting exposures

Records of dose assessment should be routinely provided where required to provide a check that monitoring has been done correctly and at the required frequency. Annual doses are to be recorded and retained. Records should also include information about the method of assessment.

6.2 External Dose Assessment Methods

The radiation exposures received by workers depend on:

- Package dose rate,
- Time of exposure to package,
- Distance from package,
- Additional shielding utilised.

Packages and conveyances may have external radiation levels up to certain maximum values. Dose rate and transport index (TI) limits are shown in Table 2 for different package categories. Several dose assessment methods are available and should be utilised depending on the scope of the RPP.

6.2.1 Dose Assessment Data in the Literature

Publications are available which give the results of dose measurements for doses received by workers from transport and handling of packages containing radioactive material, for example in references [6]. For nuclear fuel cycle material, including unirradiated fuel, spent fuel and high level wastes, for various modes of transport, exposure data for workers and the public are summarized in reference [7]. Dose assessment and evaluation data may also be available from calculations for safety analysis reports.

TABLE 2. MAXIMUM DOSE RATES AND TI FOR PACKAGES

Type of package or package category	Maximum surface dose rate (mSv/h)	Maximum TI
Excepted package	Not more than 0.005	
Category I - White	Not more than 0.005	0
Category II - Yellow	More than 0.005 but not more than 0.5	More than 0 but not more than 1
Category III - Yellow	More than 0.5 but not more than 2	More than 1 but not more than 10
Category III – Yellow plus under exclusive use*	More than 2 but not more than 10	More than 10

* NOTE: although the package radiation levels may be above the Category III-YELLOW levels when transported under exclusive use, the limits that apply to radiation levels outside of vehicles will still apply .

All these sources of information can be useful in prior dose assessment and evaluation, but care should be taken to ensure that the results are applicable to the scope of any particular RPP. Special attention has to be given to comparable handling activities.

6.2.2 Assessment of Exposure Based on TI

Several investigations have been made to:

- Establish a relationship between the total number of TI transported by a company and the doses received during the handling and transport,
- Determine the dose per unit TI from good practice in a specific operation, and
- Define a threshold value for the number of TI transported in a year below which the dose to workers in specific circumstances was below the value of 1 mSv/y.

Where a transport operator is involved in the regular shipment of similar consignments from year to year then it is possible to estimate exposures from normal transport by examination of previous exposure data. The same types of transport operations undertaken under similar conditions are likely to result in similar exposures from normal transport. Such data are particularly available to most of the major transport organizations. Some studies of transport operations involving radiopharmaceuticals and other packages have shown a correlation between the occupational dose and the TI for particular operations.

The external radiation levels of excepted and Category I-WHITE packages are, so low that they are generally considered to be safe to handle without any major operational restrictions and an explicit dose assessment may therefore not be required for operations involving exclusively low-level radiation packages (see Table 3 for further information). With proper justification such data could be part of a dose evaluation. However, the operator needs to demonstrate that their operations and

radiation exposures are commensurate with best practices.

For other categories of radioactive material shipments (e.g. for nuclear fuel cycle material) however, comparable empirical collective dose to TI ratio data are currently unavailable in widely distributed form but may be used if that information is available and is justified.

TABLE 3. NUMBER OF PACKAGES HANDLED RESULTING IN AN EXPOSURE OF 1 MILLISIEVERT/YEAR DEPENDING ON THE CATEGORY OF PACKAGES

Category of packages	Minimum number of packages handled resulting in individual occupational exposure exceeding 1 mSv/y	
	Scenario: for each package, worker is located 1 m for 30 minutes	Scenario: for each package, worker is located at contact for 5 minutes and 1 m for 25 minutes
Category I - White	4,000	1,600
Category II - Yellow	200	40*
Category III - Yellow	20	7**
Category III + exclusive use	0	0

* 40 packages with an average dose rate of 0.25 mSv/h at contact and TI=1
** 7 packages with an average dose rate of 1.25 mSv/h at contact and TI=10

6.2.3 Point Source Calculations

Taking into account the dose rate limits of the different package categories it is possible to calculate, as an example, the number of packages that will lead to a dose of less than 1 mSv/y for workers, taking into account only external exposure. Table 3 provides estimates of the number of packages of each category that can be handled before a worker would receive 1 mSv from external exposure. The numbers are based on the maximum dose rate expected from a package in each category. This table may be used to show how many packages could be handled before a worker could potentially reach a dose of 1 mSv. In all cases operational procedures should be reviewed to comply with good practice.

An important rule applies to a source small enough to be considered a point source. This rule is the inverse square law. It states that the intensity of radiation at a certain distance from a source is inversely related to the square of the distance. In equation form the inverse square law is:

$$I_1 d_1^2 = I_2 d_2^2$$

where I_1 and I_2 are the dose rates at distances d_1 and d_2 respectively.

This rule applies to a point source and may apply at large distances from a packaged source.

6.2.4 Analysis by Computer Code

In some cases it may be necessary or practical to use computer codes to perform dose assessments, such as *RADTRAN 4* [8], *INTERTRAN 2* [9], *RISKIND* [10] or *MICROSHIELD* [11].

6.3 Internal Dose Assessment Methods

Where necessary airborne radioactivity and surface contamination data should be considered for the assessment of the potential internal dose. Moreover, internal exposure to a worker can be based on measurements of quantities of radioactive material in his body, such as whole-body monitoring or biological analysis. The approaches and models involved in the assessment for the potential internal dose are, however, generally more complex than for the external exposure.

6.4 Dose Limits, Dose Constraints and Optimisation

The radiation protection requirements, given in the IRRs set a limit on effective dose for members of the public of 1 mSv/y and for workers 20 mSv/y. Additionally, dose limits in terms of equivalent dose for the lens of the eyes, extremities (hand and feet) and skin are specified in the IRRs.

Dose constraints are an important feature of the optimisation procedure in that the operations-related values of individual dose limit the range of handling/shipping options and arrangements principally available for the movement of a radioactive material from the consignor to the final destination. Dose constraints may be established to represent some fraction of the dose limit. It has been suggested that an acceptable choice of a suitable level of individual dose may be based on transport doses likely to be incurred in well-managed transport operations. Dose constraints relate to predicted doses or risks to individuals. Dose constraints are intended to reflect that which should be achievable by the application of good practices. Dose constraints may be established or agreed to by the Competent Authority. In setting values the cumulative effects of exposures from other sources should be taken into account. Dose constraints can be developed for specified tasks. However, dose constraints need not be established where operations already result in insignificant doses.

Operational limits prescribed by the regulatory agencies and restrictions applied by the management to specific operations as part of day-by-day control of exposures should not be confused with the dose constraints in the sense defined above. Nevertheless, operational limits may prove to be very efficient in controlling radiation exposures to personnel for routine transport operation conditions.

In practices giving rise to radiation exposures, radiation protection should be optimized to keep exposures “as low as reasonably achievable”, economic and social factors being taken into account. This principle is known as ALARA. The following are suggested to help judge if an action is reasonable:

(a) Common Sense: this reflects experience, knowledge and the exercise of professional judgement. For example, a very low cost yet practical change that reduces dose probably should be done even if doses are

already low.

(b) Good Practice: this compares what has been or is expected to be achieved with what has been achieved for similar or related facilities or practices. Care must be taken to ensure that reasonableness is maintained and that unwarranted expenditures do not become the norm.

The principal radiation protection arrangements in the use, handling, carriage and delivery of packages containing radioactive material may be diverse in nature but may, for example, include the following elements:

- review of individual and collective dose profiles and comparison with predicted dose profiles with a view towards identifying any problem areas,
- application of suitable segregation distances,
- adequate shielding arrangements,
- specific stowing, loading, unloading and tie down instructions for high TI-packages,
- availability and application of operational dose limits,
- access restrictions for "high background" areas,
- application of "dose minimising" working schedules for personnel, e.g. job rotation provisions depending on the occupational dose incurred,
- routine use of auxiliary package movement and lifting equipment,
- driving and routing restrictions depending on the road and weather conditions (minimization of potential exposures).

Transport organizations or programmes resulting in low occupational exposures may require only basic implementation of the optimisation principle.

Feedback structuring and analysis

The collection of relevant information combining transport operations, radiation measurements and dose assessments may be achieved in a structured document analysis of which will be useful for optimisation. Reviews of accident conditions and the means used to prevent recurrence are necessary in addition to those of routine and normal conditions. The feedback analysis may include investigation levels of dose, intake or surface contamination above which a review of the protection arrangements should be initiated to address the cause of the excess exposure and the corrective actions to be taken. Periodic evaluations are necessary.

7. SURFACE CONTAMINATION

The handling and use of radioactive material including its transport has the potential to result in radioactive surface contamination in working areas, on packages, equipment, conveyances and personnel and may result in an uncontrolled spread of radioactivity in working environments and the public domain. The type and likelihood of occurrence of surface contamination in transport reflect both the degree of containment and the effectiveness of the operational controls and depends on the type and stage of transport operations. Pond-loaded nuclear spent fuel transport casks are known to be more vulnerable to the presence of radioactive contaminants on surfaces than packages containing sealed radiation sources. Consequently the nuclear spent fuel casks require more intensive monitoring for surface contamination than would be needed for the handling and shipment of encapsulated radioactive material packages. Packages transported for medical and general industrial use have an excellent record in demonstrating the absence of surface contamination.

To prevent the spread of radioactive contaminants and to ensure that surface contamination is as low as practicable under routine transport conditions and below the contamination limits, routine or periodic monitoring for contamination on surfaces of packages, components, equipment, conveyances and personnel will be required in some cases. Monitoring programmes for surface contamination thereby assist (a) to detect failure of containment or deviations from good operating procedures and (b) provide information for planning of programmes for potential internal exposures and corrective measures on operational procedures. The frequency of monitoring should be commensurate with the potential for surface contamination in transport operations.

The RPP should identify the applicable criteria for controlling (fixed and non-fixed) surface contamination in working areas and on packages, conveyances and the equipment within a transport organization and provide an outline of the type and extent of the contamination-monitoring programme. The conventional approach to routine monitoring for surface contamination is to monitor a representative fraction of surfaces in an area or on packages at a frequency dictated by experience. However, routine monitoring of conveyances and equipment for surface contamination is not normally needed where special form radioactive material is transported.

Details of the monitoring techniques depend strongly on the type of radioactive material in question, fission products, isotopes etc., therefore proper selection must be made with respect to monitoring equipment.

8. SEGREGATION AND OTHER PROTECTIVE MEASURES

The external dose rates from packages of radioactive material can be high but exposures to workers and members of the public can be limited by adequate segregation of persons from such packages or by the use of other protective measures. For example the Competent Authority may authorize a special arrangement whereby additional safety measures may be required to compensate for a relaxation in another area such that the overall level of safety is maintained.

8.1 Segregation

For many years segregation requirements have been part of the modal regulations. The dose level of 5 mSv/y for occupationally exposed workers and 1 mSv/y to the critical group for members of the public are specially defined values to be used for the purposes of calculating segregation distances or dose rates for regularly occupied areas. The distances and dose rates are, for convenience, often presented in segregation tables. The values of 1 mSv/y and 5 mSv/y for effective dose are for segregation distances or calculation purposes only and are to be used together with hypothetical but realistic parameters in order to obtain appropriate segregation distances. Using the given values provides reasonable assurance that actual doses from the transport of radioactive material will be below the appropriate average annual dose limits. These values together with simple, robust modelling have been used for a number of years to derive segregation tables for different modes of transport. Continued use of segregation tables is acceptable, based on surveys of exposure occurring in air and sea transport which have shown that the use of such segregation distances has resulted in doses to workers and to members of the public well below the relevant annual dose limits. The use of segregation distances does not in itself remove the requirement for undertaking the optimisation evaluation.

8.2 Controlled and Supervised Areas

The IRRs state that a controlled area is an area in which specific protective measures or safety provisions are or could be required for controlling normal exposure or preventing the spread of contamination during normal working conditions; and preventing or limiting the extent of potential exposures. The IRRs also state the necessary physical controls and equipment to be used.

This concept is applied to fixed installations, but in the transport of radioactive material other systems of control can be appropriate. For example, a moving conveyance is not a controlled area for practical reasons, but areas within a conveyance might be so designated. During storage-in-transit controlled and supervised areas are common. Also for scheduled and non-scheduled stops and overnight stops during road transport, control provisions are foreseen. In the Approved Code of Practice (ACOP) [12] for the IRRs it says that under normal conditions of transport or movement around a site, it is unlikely that a controlled area would exist outside of the edges of the package provided the package meets the transport regulations.

A major problem in designating a conveyance as a controlled or supervised area comes when the conveyance needs to cross borders and the requirements may differ.

As an example the transport of radioactive material by air could be seriously impeded if the aircraft was designated a controlled or supervised area.

Transport safety deals with workers and with members of the public. In addition to controls on the package, the transport regulations also have restrictions for conveyances with respect to exposure rate (for example 0.1 mSv/h at any point 2 m from the external surface of the conveyance). Transport Safety includes the design, manufacture and preparation of the package. The package itself forms the primary containment and areas outside the package are subject to many controls for both the package and the conveyance .

Another provision in transport controls is that packages with external radiation fields (packages with II-yellow or III-yellow labels) are transported such that no persons other than driver(s) and other assistants are allowed to be in the vehicle during road transport.

9. EMERGENCY RESPONSE

In spite of all measures taken to ensure the safe transport of radioactive material there is still a finite probability that incidents and accidents involving radioactive material may take place in the public domain. Such events may occur for various reasons with several outcomes. The operators may generally be responsible for their emergency plans for events occurring during their operations. However there will be other events which need broader arrangements, for example packages may be lost, incorrectly delivered, unclaimed or unexpectedly found.

In the UK the operator must have adequate emergency plans. For example the major consignors have combined to provide emergency response through a scheme RADSAFE [13]. In addition there is a national scheme NAIR [14] available to support the police in an emergency on matters of radiation protection concern.

The objective of emergency response is to minimize the risk associated with transport incidents and accidents by providing a rapid and adequate response to such accidents. An adequate response may be defined as one in which potential or actual damage to persons, property and the environment is stabilized and ameliorated to the extent possible. This includes adequate medical and radiological care for any injured or contaminated persons, proper disposition of the radioactive material and cleanup of any radioactive material dispersed by the accident and restoration of the accident site to its normal condition and function. In some cases some actions may require a longer time; in such cases the initial response should at least assure adequate medical care for any injured persons and stabilization of any damage to property or the environment.

Planning and advance preparation is generally necessary to assure that emergency response is timely and adequate when needed. The emergency response plan should address immediate actions that will be taken in the event of transport emergencies. The consignor may assist the various carriers with the procedures to be followed, or with access to appropriate arrangements. A mechanism or procedure should be established to ensure that the carrier or responding officials (such as traffic police or fire departments, for highway or rail accidents) will be able to recognize when radioactive material is involved and whether other dangerous substances may be present, and will immediately notify the consignor and any appropriate authorities of the accident. Emergency instruction to carrier employees should be kept simple, clear and limited.

Appropriate authorities, the carrier and the consignor should be prepared to react rapidly to a radioactive material transport emergency. The plan should take into account the potential consequences of such events, and should include provisions to follow all relevant modal and other regulatory and reporting requirements.

The plan should also contain a mechanism to immediately contact a person knowledgeable and professionally trained in radiation protection procedures, to assess the state of the radioactive material involved, and to determine how it should be dealt with (e.g., authorizing continued transport of undamaged packages, controlling and cleaning up spills, properly disposing of spilled material or damaged packages, and assuring that doses to all persons involved are minimized during these activities).

Part IV of the Radioactive Material (Road Transport) Regulations 2002 covers radiological emergencies and intervention arrangements: this Part is given in Appendix 2. It includes the duties of those operators involved in the emergency.

10. TRAINING

In order to improve safety and radiation protection in a working environment including the transport of radioactive material a prime aim should be to make everyone involved "safety conscious" and committed to good radiation protection practices. Therefore, the provision of training and information is an important part of the system of radiological protection with the principal goal to keep doses "as low as reasonably achievable."

Training should be provided at three basic levels:

- General Awareness Training
- Function Specific Training
- Safety Training, including Emergency Response Training

Training should relate to specific jobs and duties, to specific protective measures to be undertaken while fulfilling normal job functions, in the event of an accident, or related to the use of specific equipment. It should include information relating to the nature of radiological risk and knowledge of the nature of ionizing radiation, their effects and their measurement, as appropriate. Training should be seen as a continuous commitment throughout employment, and involves initial training and refresher courses at appropriate intervals. The effectiveness of the training should be periodically evaluated. Records of relevant training are required.

It is understood that some radioactive material transport employees may have received training and qualification in the principles of radiological protection for reasons other than the transport of radioactive material (e.g., as nuclear plant workers, or isotope laboratory staff). In such cases some of this training may be deemed to satisfy a portion of the Radiation Protection Programme training requirements for radioactive material transport workers.

Carriers will usually be required to provide specific training in accordance with the requirements of the pertinent modal organization.

It should be noted that the specific work situations in which a radioactive material transport worker is required to work vary greatly from one employer to another, or even within the same consignor or carrier entity, so that radioactive material transport worker training should be oriented towards his or her specific or potential job functions and working environment. That is, a graded approach is recommended, in which the amount, type and complexity of training is commensurate with the degree of hazard and type and complexity of the radioactive material transport duties.

11. QUALITY ASSURANCE

It is essential that any operational RPP be subjected to review and detailed appraisal at regular intervals if an optimized standard of protection is to be achieved and maintained.

This QA programme, which must be acceptable to the Competent Authority, should be developed consistent with applicable standards for all planned and routine activities where it is judged necessary to provide sufficient confidence that these activities satisfy given requirements. A QA programme should be fully documented. The degree and detail in a QA programme will generally depend on the phase and type of transport operations.

It should be noted that an adequate QA programme encompasses a wider range of radioactive material transport operations than those normally dealt with in a transport Radiation Protection Programme.

The Radioactive Material (Road Transport) Regulations 2002 contain requirements on quality and compliance assurance programmes.

12. OUTLINE EXAMPLES OF RADIATION PROTECTION PROGRAMMES

The following outline examples of radiation protection programmes are intended to show what needs to be addressed within an RPP for specific types of transport operations. They are not complete but they are illustrative, and can go beyond regulatory requirements.

12.1 Example of an RPP for a Consignor

1. Scope

Consignments of fresh enriched uranium fuel assemblies for transport by any mode of transport.

- Package: Type A packages containing fissile material.
- This RPP covers the preparation of loaded packages for transport.
- Workers are monitored individually as specified in the licensed radiation protection system of the facility.

2. Roles and responsibilities

- Overall responsibility for the RPP
- Responsibility for package dose rate and contamination control
- Responsibility for complying with the duties of a consignor and for signing the consignors' declaration.

3. Dose assessment and optimisation

Covered by the radiation protection system of the facility

4. Surface contamination

Procedures for controlling surface contamination should be specified.

5. Segregation and other protective measures

- Not applicable for the RPP
- May be required for criticality safety.

6. Emergency response

- To give emergency cards and other relevant information to carriers.
- Emergency preparedness by providing a link from the carrier to the emergency team of the facility.

7. Training

- According to the training plan of the plant.

- Training of staff that has consignor's responsibilities specifically in matters of RADIOACTIVE MATERIAL transport.

8. Quality Assurance

Application of quality criteria, such as document control, document review, issuance and review of instructions and procedures, follow-up of nonconformities, etc. should be done in accordance with the existing QA programme.

12.2 Example of an RPP for Air Transport

1. Scope

Cargo handling for domestic and international air transport of radioactive material.

2. Roles and responsibilities

The company should designate persons who are responsible for:
- The overall RPP
- Transit storage and loading
- Training of personnel
- Access control and emergency response during in-transit storage, loading and in flight.

The necessary resources should be provided.

3. Dose assessment and optimisation

Dose assessment is required to identify the level of potential individual exposure to determine monitoring requirements, if any. Dose to crewmembers and passengers is limited by pre-established segregation distances. The ALARA (as low as reasonably achievable) principle is met by increasing segregation distances beyond minimum requirements where possible.

4. Surface contamination

Surface contamination checks on packages are not the responsibility of the cargo handlers, but are the responsibility of the consignor. Any required contamination checks on aircraft used for the transport of radioactive material are the responsibility of the carrier.

If any operator has any doubt about the integrity of a package, the procedures as outlined in the ICAO Technical Instructions [15] have to be followed.

5. Segregation and other protective measures

If transit storage takes place for any appreciable amount of time, measures may need to be taken to ensure proper segregation.

To ensure no dose limits are exceeded minimum separation distances during transport, according to the ICAO Technical Instructions, should be planned prior to loading. In order to ensure that the doses to the public and crew are as low as reasonably achievable, segregation distances should be increased where possible and access to cargo areas limited.

6. Emergency Response

Emergency response requirements should be specified for on-ground use: during flight they should be in accordance with the ICAO Emergency Response Guide.

7. Training

Specific training for an RPP should be provided to personnel in concurrence with the requirements in the ICAO Technical Instructions.

8. Quality Assurance

Application of quality criteria, such as document control, document review, issuance and review of instructions and procedures, follow-up of nonconformities, etc. should be done in accordance with the existing QA programme.

12.3 Example of an RPP for a Road Carrier

Scope

This RPP covers the shipment of encapsulated and non-encapsulated sources, nuclear fuel samples, contaminated and activated material, conditioned and unconditioned waste.

The radioactive material may be packaged in excepted, industrial, Type A, Type B(U), Type B(M), H(U), H(M) or Type C packages. The radioactive material may also be fissile material.

The shipments can be carried out if necessary under special arrangement. Normally the shipments are carried out under exclusive use, using transport equipment that is exclusively used for this type of transport. All the operators and drivers are occupational radiation workers with individual dose control on a monthly basis.

2. Roles and responsibilities

The overall responsibility for all items regarding Radiation Protection is taken by the person responsible for Radiation protection, who is, if applicable, qualified according to regulatory and legal requirements. The administrative verification of the information concerning the shipment is the role of the administrative personnel of the carrier, using a checklist[1] that indicates the different items for example:

[1] The production and updating of these checklists is the role and the responsibility of the person responsible for radiation protection.

- Information on the radioactive material:
- description of the material
- type of packages to be shipped
- activity, isotopes, amount of fissile material
- Labels on packages /expected dose levels (contact and 1 m from the surface)
- Certificate of absence of contamination
- Information on actions to be taken in the event of an emergency

The loading of the packages, securing of the packages on the vehicle, following the applicable instructions or procedures, the verification that markings and labels on the packages and placards on the vehicle correspond with the transport documents, etc. is the role of the driver. The driver uses the checklist.

3. Dose assessment and optimization

The dosimetry for the workers is performed using individual dosimeters on a monthly basis. If dosimeter readings above background (or above the "normal" value) are encountered, an explanation should be given to the person responsible for radiation protection. In some cases investigation of abnormal (high) values should be undertaken in order to avoid the same problem occurring in the future (corrective/ preventive actions).

If new types of transport are envisaged and if is not unlikely that this practice could result in dose to workers or public, a preliminary study should be carried out. This study can result in the production of appropriate specific instructions or procedures. These should be issued under the responsibility of the person responsible for radiation protection.

Before transport, dose rate measurements have to be carried out following an existing set of instructions. These measurements (contact vehicle, 2 m from the vehicle, driver's seat and – if appropriate – in contact with and at 1 m from the package(s) surfaces) have to be reported on the checklist[1]. These readings should be compared with regulatory limits and if applicable with expected or estimated values. If unexpected or non-conforming values are found, appropriate countermeasures should be undertaken.
If the radiation is not only due to gamma radiation but if there is a substantial contribution, for example due to neutron radiation, this should be taken into account.

4. Surface contamination

If third party transport equipment (vehicles, wagons, freight containers) has been used, and this equipment is not exclusively used for radioactive material transport, this equipment should be verified to be free of any contamination before further use. Other vehicles or equipment, that are used exclusively for radioactive material transport by the same carrier or company should be controlled for surface contamination on a regular basis or if incidents happened with potential contamination consequences. Contamination should be removed according to existing procedures or instructions, approved by the Radiological Protection Officer. These instructions should also take into account the safe removal of potentially

contaminated waste produced during this action.

5. Segregation and other protective measures

If II-Yellow or III-Yellow packages are loaded on a vehicle, or the consignment is under exclusive use, specific or special procedures for loading, unloading, tie down etc. could be used. These instructions or procedures should be issued under the responsibility of a qualified person.
For packages transported under special arrangement, the use of special equipment, remote handling controlled by Closed Circuit TeleVision (CCTV) may be the compensatory measures specified in the special arrangement certificate.
Although not part of a general RPP, if criticality is an issue then segregation will need to be considered for the purpose of criticality control.

6. Emergency response

A procedure or instruction for emergency response is required, and should take into account any instructions given by the consignor.

- actions to be undertaken by the driver.
- actions to be undertaken by the carrier (office)

The instructions for the driver should be very clear and limited:

1. Take care of people in danger (first aid, emergency medical help)
2. Risk of, or existence of, fire
3. Information on carriers office
4. Keep communication lines (Phone, Radio) open

It should be taken into account that the driver could be injured or not in a capacity to act. A card with pictogrammes to facilitate communication with people having different language skills, may be helpful.

7. Training

External training and on the job training in relation to the function and responsibilities of the different people (drivers, RP agents, administrative personal, secretariat) should be provided under the supervision of the person responsible for RP.
The training should be in compliance with regulatory and legal requirements and should concern the radiation hazards involved and the precautions to be observed in order to ensure restriction of their exposure and that of other persons whom might be affected by their actions.

8. Quality Assurance

Application of quality criteria, such as document control, document review, issuance and review of instructions and procedures, follow-up of nonconformities, etc. should be done in accordance with the existing QA programme.

12.4 Example of an RPP for a Sea Carrier

1. Scope

International transport by sea- going vessels of shipping line XX.

This RPP is for non-special use vessels and is established for and limited to cargo as specified below:

- material: unirradiated natural or enriched uranium products in the form of $U_3 0_8$, $U0_2$, UF_6
- packages: in compliance with IMDG Code [16]. Package types IP-1, IP-2, AF , H(U), H(M).

According to a prior assessment (may be documented separately) the staff aboard the ship is assigned, for controlling occupational exposures, to be less than 1 mSv/year.

Transport of radioactive cargo other than specified above needs assessment of dose and relevant revision of the RPP.

Roles and responsibilities

- overall responsibility for implementation of RPP
- organization concerning planning of segregation
- responsibility for training
- onboard: responsibility for limiting access to the radioactive cargo
- responsibility for emergency response

a) on board
b) b) ashore

3. Dose assessment and optimisation

Dose assessment by monitoring is not required. Dose to crewmembers is limited by pre-established segregation and limitation of access to the radioactive cargo.

As low as reasonably achievable principle is met by

- increasing segregation distances beyond minimum requirements where possible and
- limiting access to cargo area

4. Surface contamination assessment

Requirements of the IMDG Code should be met.

5. Segregation and other protective measures

Minimum separation distances according to the IMDG Code multiplied by 3 are planned prior to loading in order to meet the classification as Category 1. (The dose limits are lowered by a factor of 5, but the segregation distances are not; 3 is the rounded up value of the square root of 5.)

[Note: this may be unnecessarily restrictive since the use of segregation tables generally results in occupational exposures well below 5mSv/y.].

6. Emergency response

Emergency preparedness is in compliance with the IMDG Code and any instructions given by the consignor.

7. Training

Training requirements of the IMDG code are met.

8. Quality assurance

Application of quality criteria, such as document control, document review, issuance and review of instructions and procedures, follow-up of nonconformities, etc. should be done in accordance with the existing QA programme.

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APPENDIX 1

The Radioactive Material (Road Transport) Regulations 2002.

The UK road transport regulations include the following section on Radiation Protection Programmes:

Radiation Protection Programme

Regulation 24. - (1) This regulation applies to every carrier, consignor and consignee involved in the transport of a consignment and in this regulation an "employee" of a carrier, consignor or consignee includes any person who is an agent and any other person of whose services that carrier, consignor or consignee makes use in the transport of a consignment.

(2) Every carrier, consignor and consignee must, as respect his employees, establish a radiation protection programme which -

(a) takes into account the nature and extent of the measures to be taken in respect of the magnitude and likelihood of radiation exposure, and

(b) adopts a structured and systematic approach (including consideration of the interfaces between road transport and other activities).

(3) A carrier, consignor and consignee will be regarded as meeting his obligations under paragraph (2)(a) if he carries out and adheres to the relevant provisions of Part II (general principles and procedures) of the Ionising Radiations Regulations (1999)[15].

(4) Every carrier, consignor and consignee must -

(a) at suitable intervals (not exceeding 3 years) review and, where necessary, revise the radiation protection programme as respects his employees, such review taking into account any changes that have occurred in the transport of radioactive material to which the programme relates as well as any advances in technical knowledge and any material change to the assessment on which the programme was based;

(b) upon a written request made to him by the secretary of state, make his radiation protection programme, or any revision of it, available to the Secretary of State.

APPENDIX 2

The Radioactive Material (Road Transport) Regulations 2002

The following is an extract from the regulations:

RADIOLOGICAL EMERGENCIES AND INTERVENTION ARRANGEMENTS

Interpretation of expressions used in this Part
Regulation 66. In this Part -

"assist in the intervention" means the taking of such steps, as it is reasonable and practicable in the prevailing circumstances to take, in order to prevent or decrease exposure; the circumstances include, in particular -
(a) the weather conditions;

(b) the time of the occurrence of the emergency;

(c) the distribution of the local population;

(d) the nature and content of the package involved;

(e) the stability of the radioactive material involved;

(f) the nature of the local geography and ecology;

(g) any other prevailing hazards; and

(h) the relative importance of the emergency in relation to other calls that are being made upon the emergency services;

"emergency arrangements" means the documented plan drawn up by the consignor pursuant to regulation 68 (duties of consignor and carrier with regard to the preparation of emergency arrangements) for the purpose of providing for intervention in cases where a radiological emergency occurs during the course of transport of a consignment and which sets out the steps to be taken by those concerned with that transport to make an immediate provisional assessment of the circumstances and consequences of the emergency and to assist with intervention; and which contains provision, where the situation so requires, for intervention relating to -
(a) the source (so as to reduce or stop the direct radiation and emission of radionuclides);

(b) the environment (so as to reduce the transfer of radioactive material to individuals); and

(c) individuals (so as to reduce their exposure or to organise the treatment of

victims);

"exposure" means the process of being exposed to ionising radiation;
"initiate the emergency arrangements" means the taking of such steps, as it is reasonable and practicable to take, in order to put into effect the actions that have been planned for in the emergency arrangements;
"intervention" means any human activity taken to prevent or decrease the exposure of individuals to ionising radiation from a consignment involved in a radiological emergency by acting either upon that consignment or upon the transmission pathway giving rise to that exposure or upon the individuals so exposed;
"notifiable event" means any event where -
(a) radioactive material is lost, escapes or is unlawfully removed from the vehicle carrying the material;

(b) any package carried in or on a vehicle is opened or otherwise damaged (whether or not the package is still in or on the vehicle);

(c) the vehicle carrying the radioactive material overturns (including being turned on its side) or suffers serious damage or is involved in a fire; or

(d) a radiological emergency occurs; and

"radiological emergency" means a situation arising during the course of the transport 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.

Duties with respect to the monitoring of particular persons

Regulation 67. - For the purposes of this regulation, the provisions of Part V of the Ionising Radiations Regulations 1999[16] ("the 1999 Regulations") shall be applicable so that any person (including an employee of a carrier, consignor or consignee) who assists in an intervention and is liable to be subjected to emergency exposure shall be treated as being a person classified pursuant to regulation 20 of the 1999 Regulations and, accordingly, the carrier, consignor or consignee shall have the same duties with regard to the monitoring of such person as are imposed upon an "employer" in regulations 21 to 26 of the 1999 Regulations.

(2) In the exceptional circumstances of saving human lives, there may be an emergency exposure whereby the dose limit specified in paragraph 1, 2, 6, 7 and 8 (Workers over 18 and other persons) of Schedule 4 (dose limits) of the 1999 Regulations could be exceeded to such persons, but only where those persons are volunteers and have been informed of the risks involved in their intervention.

(3) "Employee" has the same meaning as in paragraph (1) of regulation 24 (radiation protection programme).

(4) "Emergency exposure" means an exposure of persons implementing the necessary rapid action to bring help to endangered persons or to prevent a large number of persons from being exposed to ionising radiation or to save valuable goods or a valuable installation, whereby the dose limit specified in paragraphs 1 and 2 of Schedule 4 (dose limits) of the 1999 Regulations could be exceeded.

Duties of consignor and carrier with regard to the preparation of emergency arrangements

Regulation 68. - (1) Before the transport of a package begins, the consignor thereof must have drawn up a documented plan with regard to emergency arrangements for that package.

(2) The emergency arrangements made pursuant to paragraph (1) shall be prepared having regard to the following principles

(a) intervention is to be undertaken only if the damage due to the radiation resulting from the radiation emergency is sufficient to justify the potential harm and the potential cost (including the social cost) of that intervention;

(b) the form, scale and duration of the intervention is to be optimised so that the benefit to health will be greater than any harm that might be associated with the intervention itself;

(c) the dose limits provided for in Schedule 4 of the Ionising Radiations Regulations 1999 and

(d) the Emergency Reference Levels specified by the National Radiological Protection Board (NRPB) pursuant to a direction under section 1(7) of the Radiological Protection Act 1970[17].

(3) In preparing the emergency arrangements under paragraph (1), the consignor may use or employ the services of any person (including a person who is a carrier) who has expertise in matters relating to the transport of radioactive material or of contamination.

(4) The consignor must review and, whenever necessary, revise his emergency arrangements and shall ensure that at suitable intervals they are tested.

(5) A carrier must not undertake the transport of, or cause the transport to be made of, any consignment unless he has in his possession a copy of the statement required to be given by the consignor pursuant to paragraph 23(c) of Schedule 6 of these Regulations (emergency arrangements appropriate to the consignment).

Duties of drivers, carriers and consignors in the event of the occurrence of a radiological emergency

Regulation 69. - (1) This regulation sets out the duties respectively of the driver, the carrier and the consignor in the event of the occurrence of a radiological emergency.

(2) The driver of the vehicle transporting radioactive material who discovers or has reason to believe that a notifiable event has occurred in relation to the vehicle he is driving must -

(a) immediately notify the police and (where appropriate) the fire brigade and the consignor of that event;

(b) initiate the emergency arrangements in respect of any radiological emergency

and

(c) assist in the intervention that is made in connection with that radiological emergency.

(3) A carrier of radioactive material who becomes aware of the occurrence of a notifiable event in relation to the material he is carrying must -

(a) immediately notify the police (unless the driver of the vehicle has already done so) and the Secretary of State of that event;

(b) assist in the intervention that is made in connection with any radiological emergency; and

(c) as soon as is reasonable practicable, arrange for the examination of the load that is carried in or on the vehicle so as to determine whether contamination has arisen and, if it has, to arrange for the safe disposal of any part of the load that has been contaminated and for the decontamination of the vehicle.

(4) A consignor of radioactive material who becomes aware of the occurrence of a notifiable event in relation to his consignment must -

(a) immediately notify the police and the Secretary of State of that event (unless either the driver or the carrier has already done so);

(b) assist in the intervention that is made in connection with any radiological emergency; and

(c) provide the Secretary of State with details of the incident that gave rise to that emergency.

(5) Whenever a consignor becomes aware that emergency arrangements have been initiated in relation to his consignment he must notify the Secretary of State of the initiation of those arrangements even if, in the event, no intervention was made pursuant to those arrangements.

Packages involved in a radiological emergency
Regulation 70. A package that has been involved in a radiological emergency shall not be transported or caused to be transported unless the consignor or his agent has examined it and the consignor is satisfied that it complies with the requirements of these Regulations and he issues a certificate to that effect.

Powers of inspectors and the Secretary of State in relation to emergency arrangements
71. - (1) When requested by an inspector, the carrier and the consignor must provide that inspector, within such reasonable time as the inspector may specify, with a copy of such documents relating to the emergency arrangements as may have been requested.

(2) The Secretary of State may review the emergency arrangements and may at any

time by notice in writing to a carrier or consignee require -

(a) that those arrangements be tested and, if thought appropriate by the Secretary of State, that a rehearsal be carried out of them; and

(b) that a general or specific revision or improvement be made of those arrangements.

(3) A carrier or consignor upon whom a request is made under paragraph (1) or upon whom notice is served under paragraph (2) must comply with that request or with the requirements of that notice.