IAEA Safety Standards
for protecting people and the environment

Radiation Protection Programmes for the Transport of Radioactive Material

Safety Guide
No. TS-G-1.3

IAEA
International Atomic Energy Agency

RADIATION PROTECTION PROGRAMMES FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

The following States are Members of the International Atomic Energy Agency:

AFGHANISTAN
ALBANIA
ALGERIA
ANGOLA
ARGENTINA
ARMENIA
AUSTRALIA
AUSTRIA
AZERBAIJAN
BANGLADESH
BELARUS
BELGIUM
BELIZE
BENIN
BOLIVIA
BOSNIA AND HERZEGOVINA
BOTSWANA
BRAZIL
BULGARIA
BURKINA FASO
CAMEROON
CANADA
CENTRAL AFRICAN REPUBLIC
CHAD
CHILE
CHINA
COLOMBIA
COSTA RICA
CÔTE D'IVOIRE
CROATIA
CUBA
CYPRUS
CZECH REPUBLIC
DEMOCRATIC REPUBLIC OF THE CONGO
DENMARK
DOMINICAN REPUBLIC
ECUADOR
EGYPT
EL SALVADOR
ERITREA
ESTONIA
ETHIOPIA
FINLAND
FRANCE
GABON
GEORGIA
GERMANY
GHANA
GREECE
GUATEMALA
HAITI
HOLY SEE
HONDURAS
HUNGARY
ICELAND
INDIA
INDONESIA
IRAN, ISLAMIC REPUBLIC OF
IRAQ
IRELAND
ISRAEL
ITALY
JAMAICA
JAPAN
JORDAN
KAZAKHSTAN
KENYA
KOREA, REPUBLIC OF
KUWAIT
KYRGYZSTAN
LATVIA
LEBANON
LIBERIA
LIBYAN ARAB JAMAHIRIYA
LIECHTENSTEIN
LITHUANIA
LUXEMBOURG
MADAGASCAR
MALAWI
MALAYSIA
MALI
MALTA
MARSHALL ISLANDS
MAURITANIA
MAURITIUS
MEXICO
MONACO
MONGOLIA
MONTENEGRO
MOROCCO
MOZAMBIQUE
MYANMAR
NAMIBIA
NETHERLANDS
NEW ZEALAND
NICARAGUA
NIGER
NIGERIA
NORWAY
PAKISTAN
PALAU
PANAMA
PARAGUAY
PERU
PHILIPPINES
POLAND
PORTUGAL
QATAR
REPUBLIC OF MOLDOVA
ROMANIA
RUSSIAN FEDERATION
SAUDI ARABIA
SENEGAL
SERBIA
SEYCHELLES
SIERRA LEONE
SINGAPORE
SLOVAKIA
SLOVENIA
SOUTH AFRICA
SPAIN
SRI LANKA
SUDAN
SWEDEN
SWITZERLAND
SYRIAN ARAB REPUBLIC
TAJIKISTAN
THAILAND
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
TUNISIA
TURKEY
UGANDA
UKRAINE
UNITED ARAB EMIRATES
UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND
UNITED REPUBLIC OF TANZANIA
UNITED STATES OF AMERICA
URUGUAY
UZBEKISTAN
VENEZUELA
VIETNAM
YEMEN
ZAMBIA
ZIMBABWE

The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

IAEA SAFETY STANDARDS SERIES No. TS-G-1.3

RADIATION PROTECTION PROGRAMMES FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2007

Printed by the IAEA in Austria
October 2007
STI/PUB/1269

IAEA Library Cataloguing in Publication Data

Radiation protection programmes for the transport of radioactive material. — Vienna : International Atomic Energy Agency, 2007.
p. ; 24 cm. — (Safety series, ISSN 1020–525X ; No. TS-G-1.3)
STI/DOC/1269
ISBN 92–0–109706–9
Includes bibliographical references.

1. Radioactive substances — Transportation. 2. Radiation — Safety measures. 3. Radioactivity — Safety measures. I. International Atomic Energy Agency. II. Series.

IAEAL 07–00492

FOREWORD

by Mohamed ElBaradei
Director General

The IAEA's Statute authorizes the Agency to establish safety standards to protect health and minimize danger to life and property — standards which the IAEA must use in its own operations, and which a State can apply by means of its regulatory provisions for nuclear and radiation safety. A comprehensive body of safety standards under regular review, together with the IAEA's assistance in their application, has become a key element in a global safety regime.

In the mid-1990s, a major overhaul of the IAEA's safety standards programme was initiated, with a revised oversight committee structure and a systematic approach to updating the entire corpus of standards. The new standards that have resulted are of a high calibre and reflect best practices in Member States. With the assistance of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its safety standards.

Safety standards are only effective, however, if they are properly applied in practice. The IAEA's safety services — which range in scope from engineering safety, operational safety, and radiation, transport and waste safety to regulatory matters and safety culture in organizations — assist Member States in applying the standards and appraise their effectiveness. These safety services enable valuable insights to be shared and I continue to urge all Member States to make use of them.

Regulating nuclear and radiation safety is a national responsibility, and many Member States have decided to adopt the IAEA's safety standards for use in their national regulations. For the Contracting Parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions. The standards are also applied by designers, manufacturers and operators around the world to enhance nuclear and radiation safety in power generation, medicine, industry, agriculture, research and education.

The IAEA takes seriously the enduring challenge for users and regulators everywhere: that of ensuring a high level of safety in the use of nuclear materials and radiation sources around the world. Their continuing utilization for the benefit of humankind must be managed in a safe manner, and the IAEA safety standards are designed to facilitate the achievement of that goal.

CONTENTS

1. INTRODUCTION

BACKGROUND

1.1. The IAEA has been publishing since 1961 regulations covering the safe transport of radioactive material. These regulations have been adopted by, or are used as the basis for national regulations in, many States, and are the basis for the requirements in respect of radioactive material in regulatory documents issued by the United Nations Committee of Experts for all dangerous goods, and by the various international modal regulatory bodies, including the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). Compliance with these regulations has proved to be effective in minimizing the risks associated with the transport of radioactive material.

1.2. The IAEA Transport Regulations provide a regulatory framework for all categories of radioactive material, ranging from very low activity to very high activity material such as uranium and thorium ores, spent nuclear fuel and high level waste. They cover all facets of safe transport by means of a set of technical and administrative safety requirements and controls, including the actions required by the consignor and carrier. Packaging and package requirements are specified on the basis of the hazard associated with the contents, and range from normal commercial packaging (for low hazard contents) to strict package design and performance requirements (for higher hazard contents). Specific requirements are also established for the marking and labelling of packages and overpacks and the placarding of vehicles and freight containers, documentation, external radiation limits, operational controls, emergency arrangements, management systems, and notification and approval of certain shipments and package types. In order to provide specific guidance, outline examples of radiation protection programmes (RPPs) are given in Annexes I–V. A method of evaluation of an RPP is given in Annex VI.

1.3. The IAEA Transport Regulations have undergone periodic comprehensive revision, including in 1973, 1985 and 1996. The 1996 edition was the result of a ten year review process and was published as Regulations for the Safe Transport of Radioactive Material, 1996 Edition[1], and was reissued with

---

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 1996 Edition, Safety Standards Series No. ST-1, IAEA, Vienna (1996).

minor corrections in 2000 as TS-R-1 (ST-1, Revised)[2], and again as the 1996 Edition (As Amended 2003)[3]. The current edition is the 2005 Edition [1]. Excerpts from the Transport Regulations that are relevant to this Safety Guide are provided in Annex VII.

1.4. Several IAEA Safety Guides that provide guidance on meeting the requirements of the Transport Regulations have been issued, and others are in various stages of preparation. The existing Safety Guides cover advisory material [2] and emergency response [3]. Those in preparation cover management systems for the packaging and transport of radioactive material [4] and management systems for competent authorities regulating the transport of radioactive material [5].

1.5. One major topic considered in the revision process with relevance to radiation protection is achieving consistency with the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the Basic Safety Standards, BSS) [6]. The BSS reflect Publication 60 of the International Commission on Radiological Protection (ICRP), issued in 1990 [7], and are intended to provide an appropriate standard of protection against ionizing radiation without unduly limiting beneficial practices giving rise to radiation exposure. The Transport Regulations in turn reflect the requirements of the BSS.

1.6. Guidance on meeting the requirements of the BSS for occupational protection is provided in three related Safety Guides. One gives general guidance on the development of occupational RPPs [8]. Another gives guidance on the assessment of occupational exposure due to intakes of radionuclides [9]. A third gives guidance on assessment of occupational exposure due to external sources of radiation [10]. These Safety Guides together constitute internationally recommended good practices in occupational radiation protection.

1.7. The BSS establish requirements for radiation protection for practices that may give rise to radiation exposure, on the basis of the 1990 Recommendations of the ICRP, in particular the requirements for the following:

---

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, Safety Standards Series No. TS-R-1 (ST-1, Revised), IAEA, Vienna (2000).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, Safety Standards Series No. TS-R-1, 1996 Edition (As Amended 2003), IAEA, Vienna (2004).

(a) Justification of a practice: no practice shall be adopted unless it produces a net benefit.
(b) Limitation of dose and risk to individuals: exposure of individuals shall be subject to dose limits and risk limits.
(c) Optimization of radiation protection and safety: all exposures shall be kept as low as reasonably achievable, economic and social factors being taken into account.

1.8. ICRP Publication 75 (Ref. [11], para. 92) states that:

> "Much can be achieved in optimization of protection, particularly in everyday operational control, through the use of professional judgement 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 which 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."

1.9. Radiation protection is only one element of the protection and safety of people and the environment in the transport of radioactive material by all shipping modes. RPPs are generally established and managed in conjunction with other health and safety disciplines such as industrial hygiene, industrial safety and fire safety, by means of management systems for the packaging and transport of radioactive material. An RPP should refer to these systems when appropriate.

OBJECTIVE

1.10. This Safety Guide provides guidance on meeting the requirements for the establishment of RPPs for the transport of radioactive material, to optimize radiation protection in order to meet the requirements for radiation protection that underlie the Transport Regulations (see Ref. [1], paras 301–302, and Annex VII of this Safety Guide).

SCOPE

1.11. This Safety Guide covers general aspects of meeting the requirements for radiation protection. It does not cover criticality safety, which may be necessary for packages containing fissile material, or other possible hazardous properties of radioactive material. Additional considerations that are beyond the scope of this Safety Guide apply for packages containing fissile material.

STRUCTURE

1.12. This Safety Guide consists of 11 sections. Section 2 provides an overview of RPPs. Section 4 discusses the basic elements of an RPP as a function of assessed occupational doses. Sections 3 and 5–11 provide recommendations on the basic elements of an RPP, namely the scope, the associated roles and responsibilities, dose assessment and optimization, control of surface contamination, segregation and other protective measures, emergency response, training and the management system.

1.13. Eleven annexes are included in this Safety Guide. They include examples of RPPs, relevant excerpts from the Transport Regulations [1], examples of total dose per transport index (TI) handled, a checklist for road transport, specific segregation distances and emergency instructions for vehicle operators.

2. RADIATION PROTECTION PROGRAMMES

OBJECTIVES OF RADIATION PROTECTION PROGRAMMES

2.1. RPPs are intended to establish and document in a systematic and structured way the framework of controls applied by a transport organization (i.e. any organization involved in transport, including the consignor, the carrier, the port operator and the consignee) to satisfy the radiation protection requirements and provisions established in the Transport Regulations (i.e. to limit both normal and potential exposures of workers and members of the public). RPPs thus define the radiation protection objectives of a transport organization and describe the operator's contribution to meeting these objectives.

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

(a) To provide for adequate consideration of radiation protection measures;
(b) To ensure that the system of radiological protection is adequately applied;
(c) To enhance the safety culture;
(d) To provide practical measures for meeting the radiation protection objectives.

2.3. An RPP, as defined in para. 234 of the Transport Regulations [1], is required to cover the requirements of paras 302–305, 311–314 and 563 of the Transport Regulations (see Annex VII). The RPP may be documented in one or several documents and may be a separate programme or may be a part of the operator's general programme for quality assurance (see para. 306 of the Transport Regulations [1]) within its overall management system for the transport of radioactive material. Guidance on management systems for the safe transport of radioactive material is given in Ref. [4].

OPERATIONAL RADIATION PROTECTION

2.4. The operational radiation protection provisions and controls incorporated in an RPP 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 with the level of hazards arising from the transport of radioactive material in a graded approach). Operations involving only a small number of package shipments of lower potential radiological hazard would warrant a small programme, while more significant operations (e.g. involving diverse types of radioactive material and packages being handled and shipped in the public domain) would warrant a comprehensive programme. In both cases, the workforce should be appropriately trained and the programme should be properly managed. RPPs cover all aspects of transport and the associated conditions, including (a) routine transport conditions and (b) transport and handling incidents, including accidents.

2.5. An RPP covers all aspects of transport, but the main emphasis should be put on the stages of transport operations that give rise to exposure to radiation (e.g. packing, preparation, loading, handling, storage in transit and movement of packages of radioactive material, and inspection and maintenance of packaging).

3. REQUIREMENT FOR AND SCOPE OF A RADIATION PROTECTION PROGRAMME IN TRANSPORT

GENERAL

3.1. As stated in Section 2, an RPP is required to cover all areas of transport, but the main emphasis should be on the stages of transport operations that give rise to radiation exposure (e.g. packing, preparation, loading, handling, storage in transit and movement of packages of radioactive material, and inspection and maintenance of packaging).

3.2. RPPs define and document a systematic and structured way for the framework of controls to be applied by a transport organization, with the primary aim of optimizing protection and safety in the transport of radioactive material. It is generally recognized that optimization of the 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 is only the first, but a necessary, step. In particular, for more complex shipping conditions that may involve numerous organizational and transport related activities, there will be 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 a packaging. An example would be a possible lack of safety culture on the part of the carrier or consignor. Even if radiation protection and safety have been optimized at the pre-operational stage of the shipment of radioactive material and priority is given to the package design and technical measures for controlling exposure to radiation, there will generally still be a need for the optimization of radiation protection arrangements at the various stages of transport operations.

3.3. For the operational stages of preparation, carriage, in-transit storage, intermodal transfer, unloading and delivery of radioactive material packages at the final destination and maintenance of empty packages (if contaminated or containing residual radioactive material), the General Provision on Radiation Protection embodied in the Transport Regulations [1] calls for the establishment and application of an RPP for transport. 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. In other words, the focus of an RPP for the transport of radioactive material is generally limited to transport and handling operations that have the potential to result in radiation exposures or contamination of people, property and the environment. Related activities with overpacks, freight containers and tanks as well as vehicles should be taken into account in the RPP. However, transport related operations that do not involve occupational or public exposure (e.g. administrative or clerical work) may be excluded from the requirement for the establishment of an RPP for transport.

MEETING SAFETY REQUIREMENTS

3.4. The radiation protection measures employed in an RPP may encompass a broad set of regulatory or technical safety requirements, but should be commensurate with the magnitude and likelihood of the radiation exposures (i.e. the controls should be reasonably related to the hazards arising from radioactive material transport), and consequently a graded approach is adopted, as shown in Table 1. The RPP could be brief or detailed, depending on the nature and quantity of the radioactive consignments handled by the operator.

3.5. An RPP should cover all areas of transport and the possible associated conditions of transport, including normal and accident conditions of transport. The regulatory requirements for the establishment of an RPP in the transport of radioactive material should be based on practical considerations.

3.6. According to the Transport Regulations [1] (para. 107(b)), the Transport Regulations do not apply to "radioactive material moved within an establishment which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways". This situation is found in association with transport within, for example, a nuclear power plant, an isotope production facility or a hospital nuclear medicine department, where staff members of the plant or facility may be involved in transport related operations such as the packing, loading, preparation, consigning or receipt of a radioactive material shipment. However, these organizations generally are governed by or operated under a technical and organizational framework for radiation protection that is similar to that of the standards of safety embodied in the Transport Regulations. There are cases of a dedicated carrier or shipper organization being contracted solely for transport operations of a specific consignor or consignee, with the consignor or consignee having a properly developed RPP in place that may cover the

TABLE 1. RADIATION PROTECTION PROGRAMME ELEMENTS AND OCCUPATIONAL DOSES

RPP element[a]	Occupational doses[b]		
	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
Scope of the RPP	Should consider each of the three dose ranges		
Roles and responsibilities	Should be specified for each dose range		
Dose assessment	Occasional workplace monitoring required	Workplace or individual monitoring	Individual monitoring mandatory
Dose limits, constraints, optimization	Yes, but basic optimization	Yes	
Surface contamination	Must be considered		
Segregation[c] and other protective measures	Only applicable to II-YELLOW, III-YELLOW, III-YELLOW under exclusive use (and packages containing fissile material)		
Emergency response[c]	Must be considered		
Training[c]	Must be considered		
Management systems[c]	Must be considered		

[a] Listed under para. 3.9 of this Safety Guide.
[b] A graded approach should be used as appropriate for each RPP element.
[c] Not only an RPP element; there may be broader considerations. An RPP can, however, refer to elements existing elsewhere.

carrier’s or shipper’s operations. In such circumstances the competent authority may not require the carrier or shipper to have a separate RPP solely for transport if the relevant consignor or consignee organization accounts for meeting all relevant radiation protection requirements.

3.7. The first step is to define the scope of the RPP. 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 possible number of workers involved and the duration of the operations and the distance between workers and the radioactive material are essential elements of the programme documentation that will allow the operator to define the scope of the RPP.

3.8. The description of the transport programme should include the measures that are needed to meet the requirements of the Transport Regulations for radiation protection, including monitoring provisions.

ELEMENTS OF A RADIATION PROTECTION PROGRAMME

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

(a) Scope of the programme;
(b) Roles and responsibilities for the implementation of the programme;
(c) Dose assessment;
(d) Dose limits, constraints and optimization;
(e) Surface contamination;
(f) Segregation and other protective measures;
(g) Emergency response arrangements;
(h) Training;
(i) Management systems for the safe transport of radioactive material.

Examples of RPPs are provided in Annexes I–V.

4. BASIC ELEMENTS OF A RADIATION PROTECTION PROGRAMME AS A FUNCTION OF ASSESSED OCCUPATIONAL DOSES

OCCUPATIONAL DOSES

4.1. The basic elements of an RPP are defined in the Safety Guide on Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material [2]. These elements are shown in the first column of Table 1 as RPP elements for different occupational doses. Sections 3 and 5–11 of this Safety Guide cover each of these basic elements in more detail. In situations in which occupational dose is likely to be less than 1 mSv in a year, confirmatory monitoring should be conducted. The RPP, in general, should include provisions for emergency dosimetry.

4.2. Various factors determine the importance of each of these basic elements of an RPP, such as the dose rate, the radioactive contents and activity, the number of packages transported annually and public access to packages.

4.3. Low occupational doses or only occasional transport of radioactive material does not mean that no RPP is required; for example, transport of radioactive material with high activity in heavily shielded packages generally gives rise to only low doses, but nevertheless requires thorough consideration of other basic elements such as emergency response and training.

GRADED APPROACH

4.4. Depending on the assessed effective doses due to occupational exposures arising from transport activities, a graded approach to applying the requirements of RPP elements is possible. Where it is assessed that the effective dose:

(a) Is most unlikely to exceed 1 mSv in a year, very little action needs to be taken for evaluating and controlling occupational doses;
(b) Is likely to be between 1 and 6 mSv in a year, a dose assessment programme using workplace monitoring or individual monitoring is mandatory;
(c) Is likely to exceed 6 mSv in a year, individual monitoring of the personnel involved in transport is mandatory.

4.5. High external dose rates do not necessarily result in high doses. Operational procedures and other protective measures, including segregation, should be used in such circumstances.

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

RESPONSIBILITY FOR ESTABLISHING A RADIATION PROTECTION PROGRAMME

5.1. The regulatory framework governing the transport of radioactive material assigns specific roles and responsibilities to the transport organizations (operator) and competent authorities for compliance with certain objectives, requirements and procedures relevant to safety. These duties and responsibilities are outlined below.

OPERATOR'S RESPONSIBILITIES

5.2. It is the principal responsibility of the transport organization (e.g. the consignor, carrier, port operator or consignee) to identify and document the safety and performance objectives, and to provide the necessary organizational infrastructure and resources to ensure that the objectives of the RPP are achieved in compliance with all relevant regulatory and managerial requirements in an effective manner.

5.3. The safety objectives (or policy) and the management's commitment to optimizing protection and safety for the establishment and application of the RPP should be clearly stated in the documentation of the RPP.

5.4. The radiation protection objectives pursued in the implementation and application of the RPP are best established with 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 many 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 that 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 radioactive material) in cases in which the organization or party has no direct bearing on, nor any direct responsibility for, operational radiation protection considerations.

5.5. The RPP should include, in its scope, the interfaces among the operators; for example, the consignee should develop an appropriate RPP that would require that the consignee's representatives who collect the packages from the cargo office be appropriately trained and familiar with the procedure for handling packages if they are received in a damaged condition and the preparations that they need to make when they go to the cargo office to collect their packages.

5.6. The responsibility for the implementation of an RPP therefore rests on each operating transport organization involved in the shipment of radioactive material. Carriers, consignors and consignees should cooperate. Advantage may be taken of safety provisions provided under a regulatory regime other than that for transport, thereby ensuring a commensurate standard of protection and safety. This approach also prevents the duplication of efforts and helps to avoid overlap of responsibilities.

5.7. It should be noted, however, that the competent authority may require an alternative system to be implemented and applied on a national basis; for example, by requiring the consignor to examine and evaluate the adequacy and effectiveness of the RPP of the subcontractors involved in transport activities of its own radioactive material shipments. Consignors may also decide to assist subcontractors voluntarily in the development of their RPPs.

5.8. Workers should contribute to protection and safety for themselves and others at work (see Ref. [8], paras 2.36–2.39). Workers should be made responsible for following all relevant safety procedures and for providing feedback to management.

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

5.10. Management should be responsible for ensuring that doses are limited, that protection and safety are optimized, and that appropriate RPPs are established and implemented (Ref. [8], para. 2.35).

5.11. It should therefore be 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 the optimization of protection, are properly fulfilled. This can be achieved through the adoption of adequate management systems, policies and organizational arrangements that are commensurate with the anticipated transport operations and the nature and extent of the associated hazards.

5.12. The management system should reflect the management's commitment to safety by means of written policy statements and by clear support for those with direct responsibility for protection and safety in the workplace and the public domain. The organizational arrangements should include specifying and documenting 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, providing, where relevant, facilities, suitably qualified staff, equipment, training, feedback mechanisms and the authority 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 should be clearly designated and should be given the necessary authority to implement the programme.

5.13. Preparation of the administrative and operational functions, including the establishment and application of an RPP, may be performed by a suitably qualified expert (e.g. a radiation protection officer) or an expert organization with the necessary authority to carry out actions and tasks related to safety. However, the final responsibility for ensuring compliance with all relevant regulations, decrees, directives, ordinances and standards rests with the management of the transport organization. Further recommendations are provided in Ref. [8].

RESPONSIBILITIES OF THE COMPETENT AUTHORITY

5.14. Certain requirements for protection and safety are so important that compliance with them should be independently verified. It is the principal role and responsibility of the competent authority to enforce compliance with all relevant requirements and standards, including those for the optimization of protection and safety in transport, by means of independent verification.

5.15. The elements addressed by the competent authority in reviewing an RPP may include the following. It should be checked that:

(a) The RPP is documented and implemented and is commensurate with the hazards of the transport programme of the organization and/or operator;
(b) Optimization of protection and safety is adequate and is effectively implemented (i.e. 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);
(c) Adequate training and information for workers is being provided;
(d) Mechanisms for the feedback of experience are in place;
(e) Formal arrangements for periodic reviews of radiation protection issues are in place.

5.16. In addition, the competent authority, in line with para. 308 of the Transport Regulations [1], is required to arrange for periodic assessment of the radiation doses to persons due to the transport of radioactive material.

5.17. The programme documents should be available on request for inspection by the relevant competent authority.

6. DOSE ASSESSMENT AND OPTIMIZATION

DOSE ASSESSMENT PRINCIPLES

6.1. Dose assessment and evaluation is a key issue in RPPs and relates to two fundamental considerations for radiation protection:

(a) A priori dose assessment and evaluation for workers and, when required, for the public is necessary to establish an RPP. It should be ensured that due account has been taken of all applicable radiation protection measures. A graded approach should be used for this dose assessment.

The purpose of the assessment is to describe, as precisely as necessary, the possible radiological consequences of transport operations involving radioactive material shipments. It may cover the following in particular, as appropriate:

(i) Identification of the causes of exposures and doses from routine and normal conditions of transport;

(ii) Provision, where required, of reasonably accurate estimates of the expected doses to persons and the likelihood of exposures.

(b) Radiation monitoring and dose assessment to demonstrate compliance with all relevant standards and criteria during transport, thereby establishing confidence in and continuation of good practice.

6.2. For the assessment and evaluation of transport related radiation doses, the package type, the package category, the exposure time, the dose rate, the frequency of operation, the transport volume, the use of overpacks or freight containers, the necessity of in-transit storage, the use of different modes of transport or conveyances and stowing within the conveyance should all be considered. Specific handling procedures (e.g. for small packages or packages that are remotely handled) should be taken into account.

MONITORING

Monitoring packages and conveyances

6.3. Routine monitoring made at the surface of and at a certain distance from the packages and conveyances should be detailed in the RPP to ensure both that the current authorized limits for radiation levels and surface contamination are met and that the scope of the RPP has been well defined. The nature and frequency of the monitoring, which will depend on the scope of the RPP, should be specified. The equipment to be used should be suitable for the types of radiation encountered and should be calibrated to meet the appropriate performance standards. The consignor has the primary responsibility for ensuring that dose rates 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.

Workplace monitoring

6.4. Routine monitoring in the workplace environment may be associated with continuing operations, both to demonstrate that the work conditions remain satisfactory and to meet regulatory requirements. Additionally, the results of the monitoring may be used for the purposes of dose assessment. The measurements can be performed in the storage buildings as well as in the conveyances. They comprise monitoring for external radiation and for surface contamination. The nature and frequency of the workplace monitoring should be determined in accordance with the prior radiological evaluation.

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

Individual monitoring

6.6. Where necessary, an individual monitoring programme should be a part of the RPP. Individual monitoring allows a value to be assigned to the external dose (or to rare internal dose) to an individual. The monitoring is based on equipment worn by individual workers, such as dosimeters for external exposure or personal air samplers for the rare cases in which internal exposure is a concern.

6.7. Individual monitoring is useful in ensuring compliance with the radiation protection principles of limitation and optimization of doses.

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

Recording and reporting exposures

6.9. Records of dose assessment enable a verification that monitoring has been carried out correctly and at the required frequency, and should be routinely provided where required. Annual doses should be recorded and retained. Records should also include information about the method of assessment. Further information is provided in Ref. [8], paras 5.75–5.91.

METHODS OF EXTERNAL DOSE ASSESSMENT

6.10. The radiation doses received by workers depend on:

(a) The package, overpack, freight container or conveyance dose rate;
(b) The period of exposure;
(c) The distance from the package, overpack, freight container or conveyance;
(d) Any additional shielding used.

6.11. Packages and conveyances may have radiation levels on the external surface up to the maximum values. The dose rate and TI limits are shown in Table 2 for different package categories. Several methods of dose assessment are available, and the method to be used should be determined in accordance with the scope of the RPP.

Dose assessment data in the literature

6.12. Publications are available that give the results of monitoring of and dose assessment for workers for exposure during the transport and handling of packages containing radioactive material, for example Refs [12–14]. Exposure data for workers and the public for nuclear fuel cycle material, including fresh fuel, spent fuel and high level waste, and for various modes of transport, are summarized in Ref. [15]. Data on occupational exposure arising from the transport and handling of large volumes of packages for medical and industrial use are provided in Ref. [16]. Data from dose assessments and evaluations may also be available from calculations made for safety analysis reports.

6.13. 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 within the scope of any particular RPP. Special attention should be given to whether handling activities are comparable.

Assessment of exposure based on the transport index

6.14. Several investigations have been made to do the following:

(a) To establish a relationship between the total number of TI of packages transported by a company and the doses received during handling and transport;

TABLE 2. MAXIMUM DOSE RATES AND TRANSPORT INDICES 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[a]	More than 2 but not more than 10	More than 10

[a] 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 vehicles will still apply (see, for example, para. 573 of the Transport Regulations [1]).

(b) To determine the dose per unit TI on the basis of good practices in a specific operation;

(c) To define a threshold value for the total number of TI handled in a year below which the dose to workers in specific circumstances was below the level of 1 mSV/a.

6.15. In those cases for which a reproducible correlation between TI and specific transport related activities can be demonstrated, that correlation can be used to establish a situation or site specific TI level below which monitoring would not be required for those activities. When the characteristics of these activities change in a way that might result in an increase in the total dose to a worker, a reassessment should be made.

6.16. Where a transport operator is involved in the regular shipment of similar consignments from year to year, it is possible to estimate the doses due to exposures arising from normal transport operations by means of the examination of prior exposure data. The same types of transport operations undertaken under similar conditions are likely to result in similar exposures arising from normal transport. Such data are available to most major transport organizations. Some studies of transport operations involving radio-pharmaceuticals and other packages have shown a correlation between the occupational dose and the TI for particular operations; for example, a study [13] in the United Kingdom found that, for the transport of industrial and medical radionuclides by road, a total effective dose of 1 mSv/a would be unlikely to be exceeded for transport workers handling less than 300 TI annually (i.e. a total dose to TI ratio of 3 μSv/TI). Such carriers would therefore not require detailed monitoring, dose assessment programmes or the keeping of individual records (see the Transport Regulations [1], para. 303). A similar study in the USA [14] found numbers for the total dose per unit TI of 0.6–2.3 μSv/TI. Annex VIII provides further details concerning these studies. The external radiation levels of excepted and category I-WHITE packages are so low, however, 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 should demonstrate that its operations and radiation exposures are in accordance with best practices.

6.17. For other categories of shipments of radioactive material (e.g. for nuclear fuel cycle material), however, comparable empirical data on the ratio of collective dose to TI are not at present available in any widely distributed form, but they may be used if such information is available and its use is justified.

6.18. In using the TI method, allowance should be made for unforeseen events in which the dose uptake will be more than was envisaged. In such a case, the exposure should be calculated to ensure that the employee would not receive an excessive dose by transporting the number of packages shown in Table 3.

6.19. By 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/a for workers, account being taken of external exposure only. Table 3 provides estimates of the number of packages of each category that can be handled annually before a worker would receive a dose of 1 mSv due to 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 ensure that they are in accordance with good practices.

TABLE 3. NUMBER OF PACKAGES HANDLED ANNUALLY RESULTING IN A DOSE OF 1 mSv/a, BY CATEGORY OF PACKAGES

Category of packages	Maximum number of packages handled annually resulting in an individual occupational dose not exceeding 1 mSv/a	
	Scenario: for each package, worker is located at 1 m for 30 min	Scenario: for each package, worker is located at contact for 5 min and at 1 m for 25 min
Category I-WHITE	4000	1600
Category II-YELLOW	200	40[a]
Category III-YELLOW	20	6[b]
Category III + exclusive use	0	0

[a] Forty packages with an average dose rate of 0.25 mSv/h at contact and TI = 1.
[b] Six packages with an average dose rate of 1.25 mSv/h at contact and TI = 10.

Analysis by computer code

6.20. In some cases it may be necessary or practical to use computer codes such as RADTRAN 4 [17], INTERTRAN 2 [18], RISKIND [19] or MICROSHIELD [20] to perform dose assessments.

INTERNAL DOSE ASSESSMENT METHODS

6.21. Where necessary, data on airborne radioactive material and surface contamination should be considered for assessment of possible internal doses. Moreover, internal exposure of a worker can be measured on the basis of quantities of radioactive material in the body, such as in whole body monitoring or biological analysis. The approaches and models involved in the assessment for possible internal doses are, however, generally more complex than those for external exposure. For further details see Ref. [9].

DOSE LIMITS, DOSE CONSTRAINTS AND OPTIMIZATION

6.22. The requirements for radiation protection established in the BSS [6], which underlie the Transport Regulations, set a limit on the effective dose for members of the public of 1 mSv/a and for workers of 20 mSv/a averaged over five consecutive years. This is to ensure that no individual is committed to an unacceptable risk due to radiation exposure. Additionally, dose limits in terms of equivalent dose for the lens of the eye, extremities (hands and feet) and skin are specified in the BSS.

6.23. Dose constraints are an important feature of the optimization procedure. Operations related values of individual dose restrict the range of handling and shipping options and the arrangements principally available for the movement of radioactive material from the origin of the shipment 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 made on the basis of the transport related doses likely to be incurred in well managed transport operations. Dose constraints relate to projected doses or risks to individuals. Dose constraints are intended to reflect what 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 doses from exposures due to 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.

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

6.25. To provide a high level of protection against radiation exposure, the Transport Regulations [1] are based on the provisions of the BSS [6]. They adopt the safety principle that, in practices giving rise to exposures, radiation protection should be optimized to keep doses as low as reasonably achievable, economic and social factors being taken into account.

6.26. The principal arrangements for radiation protection 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:

(a) Review of individual and collective dose profiles and comparison with predicted dose profiles with a view to identifying any problem areas;
(b) Application of suitable segregation distances;
(c) Adequate shielding arrangements;

(d) Specific stowing, loading, unloading and tie-down instructions for high TI packages;
(e) Availability and application of operational dose limits;
(f) Access restrictions for areas of high background radiation levels;
(g) Application of dose minimizing work schedules for personnel (e.g. job rotation provisions depending on the occupational dose incurred);
(h) Routine use of auxiliary equipment for movement and lifting of packages;
(i) Driving and routing restrictions depending on the road and weather conditions (for the minimization of potential exposures).

6.27. Reference [21] gives further guidance on the optimization of radiation protection. Transport organizations or programmes resulting in low occupational exposures may require only basic implementation of the optimization principle.

6.28. 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 the purposes of optimization. Reviews of accident conditions and the means used to prevent the recurrence of accidents are necessary in addition to reviews of routine and normal conditions. Analysis of feedback may involve investigation levels of dose, intake or surface contamination above which a review of the protection arrangements should be initiated to consider the cause of the exposure in excess of the prescribed levels and the corrective actions to be taken.

7. SURFACE CONTAMINATION

MEETING REQUIREMENTS IN RESPECT OF CONTAMINATION

7.1. It is a requirement of the Transport Regulations that contamination be carefully controlled for transport packages, their conveyances and other associated equipment. Many radioactive packages are completely free from contamination of the outer surface, whereas others require additional decontamination to ensure that strict ‘safe’ limits are achieved prior to dispatch. Strategies for contamination management may include prevention, decontamination and ‘minimization through design’.

7.2. For example, pond loaded transport casks for spent nuclear fuel are known to be more prone to the presence of radioactive contaminants on surfaces than packages containing sealed radioactive sources. Consequently, more intensive monitoring for surface contamination is needed for spent nuclear fuel casks than is needed for the handling and shipment of the majority of other radioactive material packages.

7.3. There is an excellent record of absence of surface contamination for packages transported for medical and general industrial use. Routine monitoring of these types of package for surface contamination by the carrier is therefore not normally necessary.

7.4. To prevent the spread of radioactive contaminants, and to ensure that surface contamination is as low as reasonably achievable under routine transport conditions and is below the contamination limits, routine or periodic monitoring for contamination on surfaces of packages, overpacks, freight containers, components, equipment, conveyances and personnel should be conducted in some cases. Monitoring programmes for surface contamination can assist in detecting failure of containment or deviations from good operating procedures, and in providing information for monitoring programmes for possible internal exposures. The frequency of monitoring should be commensurate with the potential for surface contamination in transport operations.

CONTROL OF CONTAMINATION

7.5. The applicable criteria for controlling (fixed and non-fixed) surface contamination in work areas and on packages, conveyances and equipment within a transport organization should be identified in the RPP, and an outline of the type and extent of the contamination monitoring programme should be provided. 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 determined by experience (further guidance is provided in Ref. [8], paras 539–548). However, routine monitoring of conveyances and equipment for surface contamination is not normally necessary where radioactive material in special form or in welded sealed sources meeting ISO 2919 standards (or similar) is transported.

7.6. Details of the monitoring techniques depend strongly on the type of radioactive material concerned (whether fission products or isotopes, etc.), and monitoring equipment should therefore be selected appropriately.

8. SEGREGATION AND OTHER PROTECTIVE MEASURES

SEGREGATION

8.1. External dose rates from packages of radioactive material can be high, but exposures of workers and members of the public can be limited by the adequate segregation of such packages from persons or by the use of other protective measures.

8.2. For many years the modal Transport Regulations have included segregation requirements. The dose limit of 5 mSv in a year for occupationally exposed workers and 1 mSv in a year for the critical group for members of the public are specified values to be used for the purposes of calculating segregation distances or dose rates for regularly occupied areas. The distances and dose rates are often for convenience presented in segregation tables. The values of 1 mSv in a year and 5 mSv in a year for effective dose, as given in para. 563 of the Transport Regulations [1], are for segregation distances or calculation purposes only and should be used together with conservative model parameters to obtain appropriate segregation distances. Using the given values provides reasonable assurance that the actual doses arising 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, on the basis of surveys of exposures occurring during air transport and sea transport, which have shown that the use of such segregation distances has resulted in doses to the public well below the relevant annual dose limits and that doses to workers not involved in direct handling are less than 1 mSv in a year [14]. The use of segregation distances does not in itself remove the requirement for undertaking the optimization evaluation required in para. 301 of the Transport Regulations [1].

8.3. The Transport Regulations establish the requirements for radiation protection that are to be fulfilled in the determination of segregation distances (i.e. minimum distances between radioactive material packages and regularly occupied areas of a conveyance) and of dose rates in regularly occupied areas. For practical purposes it may be helpful to provide this information in the form of segregation tables.

8.4. Paragraph 563 of the Transport Regulations [1] and appendix III of Ref. [2] address segregation distances. The International Maritime Organization (IMO) has established two methods for satisfying segregation requirements, as illustrated in Annex IX, which is taken from the International Maritime Dangerous Goods (IMDG) Code [22].

LIMITATION OF EXPOSURE TIMES

8.5. Periodic assessments of work procedures should be made to look for possible changes to implement in the procedures in order to reduce the amount of time for which the worker is in the vicinity of the packages, so as to reduce his or her radiation dose. Examples of such measures are: preparing shipping papers in a low background area instead of near the package; performing TI measurements and measurements of the package surface dose rate by automated means; using mechanical means such as dollies or carts to transport packages to and from a conveyance instead of carrying individual packages against the body; and planning the work process so that a conveyance can be loaded or unloaded in the minimum amount of time.

USE OF SHIELDING AND SHIELDING TECHNIQUES

8.6. In some instances it may be reasonable to lower the dose to the driver of a conveyance by installing shielding material between the driver and the cargo areas, or to lower the dose to the employees of the consignor or the consignee in fixed facilities by installing shielding between work areas and package storage or loading or unloading areas.

8.7. Where possible, accumulation of packages should be arranged, both in storage areas and in conveyances, so that the packages giving rise to higher dose rates are farthest from employees; in this manner not only will the dose rate to the employees be lower because of the increased distance, but in addition the packages giving rise to lower dose rates serve to shield the employees partially from the radiation emitted by the packages giving rise to higher dose rates.

CONTROLLED AND SUPERVISED AREAS

8.8. The BSS [6] and the Safety Guide on Occupational Radiation Protection [8] 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 for preventing the spread of contamination under normal working conditions, and for preventing or limiting potential exposures. The BSS and Ref. [8] also state the necessary physical controls and equipment to be used.

8.9. This concept of a controlled area is applied to fixed installations, but other systems of control may be appropriate for the transport of radioactive material; for example, a moving conveyance is not a controlled area as defined in the BSS [6], but areas within a conveyance might be so designated. For storage in transit, controlled and supervised areas are common. However, for scheduled and non-scheduled stops and overnight stops during road transport, some protective measures may be required.

8.10. Transport safety concerns workers and members of the public. The Transport Regulations set restrictions for conveyances with respect to the exposure rate (e.g. 0.1 mSv/h at any point at 2 m distance). In certain former editions of the Regulations for the Safe Transport of Radioactive Material (e.g. IAEA Safety Series No. 6 of 1985 (As Amended 1990)), the exposure rate in the driver's section was limited to 20 μSv/h. In some States a maximum dose rate limit for drivers is still prescribed.

8.11. Transport safety covers the design, manufacture and preparation of the package as well as other operations and conditions as stated in para. 106 of the Transport Regulations [1]. The package itself forms the primary containment, and areas outside the package are subject to many controls for both the package and the conveyance.

8.12. Packages or overpacks of category II-YELLOW or III-YELLOW are not allowed to be carried in compartments occupied by passengers, except those compartments reserved exclusively for couriers specially authorized to accompany such packages or overpacks (see the Transport Regulations [1], para. 564).

9. EMERGENCY RESPONSE

GENERAL

9.1. The requirements of the Transport Regulations provide for a high degree of radiological protection before, during and after an incident or accident. The transport of radioactive material has an excellent safety record. However, in spite of all measures taken to ensure the safe transport of radioactive material, there is a definite, although small, probability that accidents involving radioactive material may take place in the public domain.

9.2. Operators are generally responsible for preparing emergency plans. However, there will be other events that need broader arrangements; for example, packages may be lost, incorrectly delivered, unclaimed or unexpectedly found. The methods of, and arrangements for, emergency response to incidents during the transport of radioactive material may differ from State to State, depending on the established institutional arrangements and the resources available.

9.3. The objective of emergency response is to minimize the risk associated with transport incidents by providing a rapid and adequate response. An adequate response may be defined as one in which potential or actual damage to persons, property and the environment is mitigated to the extent possible. Such a response includes: the emergency dosimetry of persons, where so recommended by a radiation protection expert; the provision of adequate medical and radiological care for any injured or contaminated persons; the proper disposition of radioactive material and cleanup of any radioactive material dispersed as a result of the accident; and the remediation of the accident site to return it as far as possible to its normal condition and function. In some cases some actions may require an extended time; in such cases the initial response should at least ensure adequate medical care for any injured persons and the mitigation of any damage to property or harm to the environment.

EMERGENCY PLAN

9.4. Planning and advance preparation are generally necessary to ensure that emergency response is timely and adequate when needed. The emergency response plan should address immediate actions that would be taken in the event of a transport emergency. 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-fighters, for highway or railway accidents) would be able to recognize whether 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 the carrier's employees should be kept simple, clear and limited.

EMERGENCY PREPAREDNESS

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

9.6. The plan should also contain a mechanism to contact immediately 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. by authorizing the continued transport of undamaged packages, by controlling and cleaning up spills, by properly disposing of spilled material or damaged packages and by ensuring that doses to all persons involved are minimized during these activities).

9.7. Unless the lives of rescue personnel would be endangered by doing so, persons who are or may be seriously injured should be given immediate medical attention, irrespective of the presence or otherwise of spilled radioactive material.

9.8. The plan should provide for a post-incident analysis of both the incident and the response to it, to determine the measures that may be taken to minimize the possibility of the occurrence of a similar incident in the future and to improve the response to any such incident.

9.9. Further guidance on meeting the requirements for planning and preparedness for emergency response is given in Ref. [3].

10. TRAINING

NEED FOR TRAINING

10.1. Awareness of matters relating to radiation protection is maintained through the effective training of personnel. To improve safety and radiation protection in a work environment that includes the transport of radioactive material, it should be a prime aim to make everyone involved ‘safety conscious’ and committed to good radiation protection practices. The provision of training and information is therefore an important part of the system of radiological protection, the principal goal being to keep doses as low as reasonably achievable.

10.2. Training should be provided at three basic levels:

(a) General awareness training;
(b) Function specific training;
(c) Safety training, including emergency response training.

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

10.4. Some workers involved in the transport of radioactive material may have received training and qualification in 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 training requirements of the RPP for workers involved in the transport of radioactive material.

SPECIFIC TRAINING AND GRADED APPROACH

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

10.6. The specific work situations vary greatly from one employer to another, or even within the same consignor or carrier entity, and therefore the training of workers for the transport of radioactive material should be oriented towards his or her specific or potential job functions and work environment. That is, a graded approach should be adopted, in which the amount, type and complexity of training is commensurate with the nature and degree of the hazards and the type and complexity of the duties in the transport of radioactive material.

11. MANAGEMENT SYSTEMS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL

GENERAL

11.1. Any operational RPP should be subject to review and detailed appraisal at regular intervals to achieve and maintain an optimized standard of protection. The RPP should therefore be considered in the scope of the management systems that are required to be developed for the packaging and transport of radioactive material (the Transport Regulations [1], para. 306). The aim of management systems is to provide evidence that the standard of safety prescribed in the regulations is achieved in practice. A management system is a set of inter-related or interacting elements that establish policies and objectives and that enable these objectives to be achieved in an efficient and effective way. The system comprises elements of control and inspection during all phases of transport.

MANAGEMENT SYSTEMS

11.2. A management system that is consistent with relevant standards for all planned and routine activities and acceptable to the competent authority should be developed. The system should be fully documented. The principal goal for the management system is to describe the planned and systematic actions necessary to provide confidence that all safety requirements can be satisfied. The degree and level of detail in the system will generally depend on the phase and type of transport operations.

11.3. The essential elements of such a management system are identified in a number of publications, including Refs [4, 23], and are presented in a less extensive form as appendix IV of Ref. [2].

11.4. An adequate management system for the safe transport of radioactive material should encompass a wider range of transport operations than those normally dealt with in an RPP for the transport of radioactive material.

REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 2005 Edition, IAEA Safety Standards Series No. TS-R-1, IAEA, Vienna (2005).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series No. TS-G-1.1 (ST-2), IAEA, Vienna (2002).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material, IAEA Safety Standards Series No. TS-G-1.2 (ST-3), IAEA, Vienna (2002).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, The Management System for the Safe Transport of Radioactive Material (in preparation).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, Compliance Assurance for the Safe Transport of Radioactive Material (in preparation).

[6] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

[7] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, 1990 Recommendations of the International Commission on Radiological Protection, Publication 60, Pergamon Press, Oxford and New York (1991).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, Occupational Radiation Protection, IAEA Safety Standards Series No. RS-G-1.1, IAEA, Vienna (1999).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, Assessment of Occupational Exposure Due to Intakes of Radionuclides, IAEA Safety Standards Series No. RS-G-1.2, IAEA, Vienna (1999).
[10] INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR OFFICE, Assessment of Occupational Exposure Due to External Sources of Radiation, IAEA Safety Standards Series No. RS-G-1.3, IAEA, Vienna (1999).
[11] INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, General Principles for the Radiation Protection of Workers, Publication 75, Pergamon Press, Oxford and New York (1997).
[12] WARNER JONES, S.M., SHAW, K.B., HUGHES, J.S., Survey into the Radiological Impact of the Normal Transport of Radioactive Material by Air, Rep. NRPB-W39, National Radiological Protection Board, Chilton, UK (2003).
[13] WATSON, S.J., OATWAY, W.B., JONES, A.L., HUGHES, J.S., Survey into the Radiological Impact of the Normal Transport of Radioactive Material in the UK by Road and Rail, Rep. NRPB-W66, National Radiological Protection Board, Chilton, UK (2005).
[14] SHAPIRO, J., Exposure of Airport Workers to Radiation from Shipments of Radioactive Materials: A Review of Studies Conducted at Six Major Airports, Rep. NUREG-0154, United States Nuclear Regulatory Commission, Washington, DC (1977).
[15] WORLD NUCLEAR TRANSPORT INSTITUTE, Radiation Dose Assessment for the Transport of Nuclear Fuel Cycle Materials, WNTI Review Series No. 2, WNTI, London (2001).
[16] SCHWARZ, G., FETT, H.J., LANGE, F., “Occupational and public exposures arising from the normal transport of radioactive material: Experience in Germany”, Safety of Transport of Radioactive Material (Proc. Int. Conf. Vienna, 2003), Vienna, IAEA (2004).
[17] NEUHAUSER, K.S., KANIPE, F.L., RADTRAN 4: A Computer Code for Transportation Risk Analysis, Rep. SAND-89-2370, TTC-0943, Sandia Natl Lab., NM (1992).
[18] ERICSSON, A.M., JAERNRY, C., INTERTRAN 2: Transportation Risk Assessment Package, http://www.amckonsult.se/
[19] YUAN, Y.C., CHEN, S.Y., LEPOIRE, D.J., ROTHMAN, R., RISKIND: A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel, Rep. ANL/EAIS-6, Argonne Natl Lab., IL (1993).
[20] NEGIN, C.A., MICROSHIELD: A microcomputer program for analyzing dose rate and gamma shielding, Trans. Am. Nucl. Soc. **53** (1986) 421–422.
[21] INTERNATIONAL ATOMIC ENERGY AGENCY, Optimization of Radiation Protection in the Control of Occupational Exposure, Safety Reports Series No. 21, IAEA, Vienna (2002).

[22] INTERNATIONAL MARITIME ORGANIZATION, International Maritime Dangerous Goods Code, 2000 Edition, Including Amendments 30-00, IMO, London (2004).
[23] INTERNATIONAL ATOMIC ENERGY AGENCY, Quality Assurance for the Safe Transport of Radioactive Material, Safety Series No. 113, IAEA, Vienna (1994).
[24] INTERNATIONAL CIVIL AVIATION ORGANIZATION, Technical Instructions for the Safe Transport of Dangerous Goods by Air, 2001–2002 Edition, Doc. 9284-AN/905, ICAO, Montreal (2001).

Annex I

GENERIC EXAMPLE OF A RADIATION PROTECTION PROGRAMME

I–1. This annex presents practical examples of the contents of an RPP. These examples are relevant mainly to small and medium sized operators carrying radiopharmaceuticals, industrial radiography sources and nucleonic gauges. However, the examples can be adapted to a range of transport operations. The following examples of outline RPPs are intended to show what needs to be addressed within an RPP for specific types of transport operations. They are not comprehensive but they are illustrative and can go beyond regulatory requirements. A suggested checklist is provided at the end of this annex that can be used by the competent authority for determining the acceptability of the RPP.

GENERIC EXAMPLE OF A RADIATION PROTECTION PROGRAMME (ACCEPTANCE BY THE APPROPRIATE COMPETENT AUTHORITY IS REQUIRED)

Scope

I–2. The general scope of the work covered by the RPP would be included; for example: "The scope of this RPP covers the transport and storage of all radioactive material, but does not include criticality aspects." The scope may also include a brief description of the operations, such as: "This RPP covers the transport of radiographic sources." Further details on the scope of the transport operations could be included as appropriate.

Roles and responsibilities

I–3. The roles and responsibilities in the organization may, for example, be specified as follows:

> "The RPP shall be managed by a suitably qualified person.
> "The person having overall responsibility for the RPP must ensure that all of the requirements of the RPP are in place, including:
>
> (a) Training of workers and implementation of proper working procedures;
> (b) Assessment of worker exposures, if necessary by individual monitoring or area monitoring;

(c) Emergency procedures.

"The person(s) appointed for the role of managing the RPP is/are:

…………….

…………….

"Specific roles

"Specific roles may be delegated by the appointed persons to fulfil the following duties:

"Verification of/for compliance:

(a) Description of the material in the shipment;
(b) Types of package to be shipped;
(c) Activity, isotopes;
(d) Shipper's declaration;
(e) Labels on packages, containing all the required information;
(f) Markings on the package;
(g) Certificate of conformance with the contamination limits;
(h) Information on action to be taken in an emergency;
(i) Conditions for storage, loading and securing of the packages on to the conveyance;
(j) Placarding of the conveyance;
(k) Measurements of dose rates around the loaded conveyance.

[There may be other supplementary requirements in addition to the above: a checklist similar to the example in Annex X may be used.]

"The following persons have responsibility for the above duties:

…………………

…………………

"(e.g. driver, loaders, acceptance staff)"

Dose assessment and optimization

I–4. Dose assessment is necessary to determine the level of individual potential exposure and to determine monitoring requirements, if any. Worked examples are given below. Initial assessments should be made on the basis of:

(a) The number and type of packages;
(b) The category of packages and the TI moved;
(c) The radionuclides being shipped;
(d) The frequency of shipment;
(e) The duration of storage and transport.

I–5. The information presented in Section 6, for example in Table 3, may give some initial guidance on these assessments. It may be necessary to monitor packages, conveyances, workplaces and workers to verify these assessments. For workers who receive very low doses or who work in areas subject to workplace monitoring, individual monitoring may not be necessary. For workers performing other tasks, individual monitoring may be necessary, and it may be necessary to keep dose records. Depending on the doses received, appropriate health surveillance for workers may also be necessary.

Optimization

I–6. In some organizations, full assessments of dose optimization may be appropriate. For small to medium sized operators, there may be a number of ways to minimize exposures, and, depending on the work circumstances, practical measures can be specified in the RPP:

> "The dose is to be kept as low as reasonably achievable by increasing segregation distances beyond the minimum requirements, where possible."
> "A trolley must be used to take the packages from the storeroom to the loading area."
> "In the storeroom, packages must be kept in the shielded bays until as late as possible before loading."

Example 1

I–7. The company will transport approximately three category III-YELLOW packages per week, with an average TI of 3 per package. The weekly number of packages may vary, but the annual volume of shipment is expected to be about 150 packages. In this company the tasks of the driver and the handler who loads the vehicle are separate.

Handler

I–8. Table 3, column 4, indicates that annual doses below 1 mSv may be expected if six packages each with a TI of 10 are handled annually. For packages with a TI of 3, an annual dose of about 1 mSv would correspond to an annual number of about 20 packages. The expected number of packages to be shipped is some eight times greater, and therefore individual monitoring is indicated for the handler.

Driver

I–9. The driver is expected to make one 4 h journey each week to take the three packages to the consignee, giving an annual driving time of about 200 h. The packages will be 3 m from the driver, and there is no significant shielding in the truck. The dose rate at the driver's position is therefore approximately:

$$3 \times 30/3^2 \ \mu Sv/h \approx 10 \ \mu Sv/h$$

For an exposure time of 200 h, the driver is therefore expected to receive about 2 mSv annually, and either individual monitoring or area monitoring would be necessary. The former would be preferable, owing to the expected variability in exposure conditions.

Example 2

I–10. A driver will transport an industrial gauge to the company's sites for it to be used by technicians at those sites. All loading and unloading operations are carried out by technicians. The annual driving time is expected to be about 200 h. The gauge is carried within a category II-YELLOW package with a TI of 0.1 and is located in the vehicle 2 m from the driver. The dose rate at the driver is therefore:

$$\approx 1/2^2 \ \mu Sv/h \approx 0.25 \ \mu Sv/h$$

I–11. The driver's annual dose is therefore expected to be about 0.05 mSv, and therefore no monitoring will be required. However, individual monitoring is recommended for a limited period to confirm this assessment.

Surface contamination

I–12. This section may include, for example:

> "The radioactive material to be transported is either special form sources or non-special form sources, carried in intact packages. Situations may arise involving damage to packages, and in these situations the person responsible for managing the RPP will make checks for contamination by taking swabs of the package surface and surrounding areas using an appropriate instrument and following appropriate procedures. Periodic checks for contamination are made of the work area and conveyances."

I–13. Other conditions may be specified, depending on the organization’s procedures:

> “When required, the company’s radiation specialist will be called in to perform contamination checks.”
> “Conveyances (or areas of conveyances) that have been used for the transport of radioactive material must be checked for contamination before being used for other purposes.”

The results of the periodic checks need to be recorded and retained.

Segregation and other protective measures

I–14. The relevance of package segregation will depend on the type of operations carried out. If category II-YELLOW or III-YELLOW packages are stored or loaded on a conveyance, or if the consignment is under exclusive use, specific or special procedures for storage, loading, unloading, tie-down, etc., could be used. These instructions or procedures would be issued under the responsibility of a qualified person.

I–15. For example, in the case of a single radiography container or gauge:

> “The container is to be kept in the store when not in use. During transport, the container is to be placed in the rear of the goods compartment of the vehicle.”

I–16. Package segregation is normally only relevant for operations involving the transport and in-transit storage of many packages containing medical radiopharmaceuticals, especially ^{99}Mo/^{99m}Tc, Rb/Kr generators or ^{131}I.

I-17. A number of factors need to be taken into account in determining the segregation of packages from occupied areas, and it may be necessary to consult a radiation protection specialist. As an example, the RPP could set out the arrangements for an in-transit storage area as follows:

> “The storage area is 10 m from the office where office workers normally work full time. The company regards these workers as members of the public in the context of radiation protection. The packages are stored for a maximum of 1 h per day, and the maximum number of TI in the storeroom is limited to 10. With this maximum TI, and without considering the effect of shielding by the walls, the dose rate at 10 m

would be 1 μSv/h, giving 1 μSv per day and an annual dose of about 250 μSv (0.25 mSv). However, the concrete storeroom walls, which are 40 cm thick, provide a dose rate reduction factor of over 100, and therefore annual doses are anticipated to be of the order of 2 μSv. The office walls provide some extra shielding, and the average TI stored will not normally be at the maximum; this will therefore be an upper estimate of the doses received by the office workers."

I–18. Another situation in which segregation from package handling operations is appropriate is in the receipt and dispatch of medical radioisotopes at an air cargo shed:

"A consignment of packages containing radiopharmaceuticals is received at a cargo shed from a large consignor on four working days each week. The packages are unloaded from the truck in an area of the shed well away from the nearest area normally occupied by other workers. The packages are sorted and placed on pallets according to their respective destinations. The prepared pallets are immediately moved into a shielded storeroom from which they are taken out when required to be loaded on to a cargo aircraft. The cargo handling staff who carry out this work are subject to individual monitoring and typically receive annual doses in the range of 2–3 mSv. The typical daily TI handled is about 20, and the sorting procedure takes some 15 minutes. At 3 m from the consignment of packages the dose rate is about 20 μSv/h. Occupancy at that distance for 15 minutes would give a dose of 5 μSv daily and around 1 mSv annually. Although no other persons are normally present in the vicinity, warning signs and a tape barrier would be placed at about this distance to demarcate the limit of the supervised area, for the duration of the work."

I–19. Consideration also has to be given to other methods of dose reduction; for example, for road transport:

"Where possible, all packages, especially the high TI packages, are to be placed at the rear of the goods compartment. Shielding of about 3 mm of lead is provided in the vehicle behind the driver's cabin."

I–20. This will minimize the exposure of the driver. As an additional method of dose constraint, this RPP may specify a maximum dose rate for the driver's cabin, although this is not a requirement of the Transport Regulations [I–1]. The conveyance would be provided with lead shielding of thickness 3 mm behind the driver's cabin.

I–21. This following will reduce the dose to the loaders:

> "The high TI packages are to be kept in the storeroom as long as practicable, and would be the last to be loaded."

I–22. Although it is not part of a general RPP, if criticality safety is an issue, then segregation in storage and limitation of the criticality safety index on conveyances will need to be considered for the purpose of criticality control.

Emergency response

I–23. A procedure or instruction for emergency response is required, and such a procedure or instruction has to take into account any instructions given by the consignor. For accidents involving radioactive material in storage areas, or carried by road or rail, the procedures to be followed are often specified in national legislation, and they may vary slightly from State to State. Similarly, for accidents involving packages being handled at air cargo centres, procedures may be specified in national legislation. These procedures have to be reflected in the RPP. The requirements of emergency response procedures are similar, despite national variations. An example of emergency response procedures for road transport is given below:

> "In the event of an accident during the road transport of radioactive material, the driver of the vehicle must:
>
> (a) Take care of people in danger (first aid, emergency medical help);
> (b) Assess the risk of, or occurrence of, fire and use the fire extinguisher if appropriate;
> (c) Call the police;
> (d) Call the fire service and an ambulance if appropriate;
> (e) Inform the 'responsible person' at the main (carrier's) office;
> (f) Keep communication lines (telephone, radio) open.
>
> "These instructions are included on the information card in all the vehicles. However, the driver could be injured or not in a condition to act, and vehicles carrying radioactive material are therefore provided with a fireproof notice in the cab to alert the police that there may be radioactive material on the vehicle."

I–24. A card with pictogrammes, such as that shown in Annex XI, to facilitate communication with people having different language skills may be helpful.

An example of supplementary instructions provided in different languages is also shown in Annex XI.

I–25. Following notification of an emergency to the main office:

> “The responsible person must inform the consignor/consignee and competent authority of the accident.”

I–26. Subsequent procedures may be included regarding recovery and cleanup, but these will vary from State to State. An example may be:

> “The responsible person must arrange, with the consignor and competent authority, for recovery of any damaged packages, decontamination and disposal of any waste or debris.”

I–27. In practice, further, more specific, details would normally be included, for example details of names, 24 h telephone numbers and exact procedures for dealing with decontamination and waste disposal. Similar procedures can be specified for storage areas and for other modes of transport.

Training

I-28. The training of the relevant workers has to be specified, and normally a graded approach is necessary to cover the range of tasks involved. Normally there will be tasks at a managerial/supervisory level (responsible officers) and other training for workers carrying out particular tasks; for example:

> “The following responsible persons have received training and have gained the appropriate certificates for fulfilling their duties:
> ……………………
> ……………………”

I–29. An example of a consignor’s RPP may include:

> “The following persons have received job specific training:
> ………………………
> ………………………

> “This training verified that they are able to carry out the following duties:

(a) Completion of transport documents;
(b) Preparation of packages;
(c) Measurements of dose rates and TI;
(d) Completion and application of package labels;
(e) Loading of packages on to the vehicle;
(f) [Include further tasks as appropriate]."

The RPP can include a statement on the revalidation of certificates that are subject to the requirements of the competent authority and to the employer's policies.

Management system for procedures and practices

I–30. The RPP is part of the employer's system of documents on the management system, and is subject to all the requirements of the management system for procedures and practices, such as those for document and version control, document review, issuing and review of instructions and procedures, and follow-up of non-conformances. The RPP has to be approved by a suitable person, and in some cases by the competent authority; for example:

"This RPP,

Version No. ………… is approved.

Signature………………., Date: …….

(Name and designation)"

REFERENCE TO ANNEX I

[I–1] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 2005 Edition, IAEA Safety Standards Series No. TS-R-1, IAEA, Vienna (2005).

Annex II

SPECIFIC EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOPHARMACEUTICALS

II–1. This is an operating manual on the radiation protection programme of ABC Radiopharmaceuticals. The institution undertakes to implement the provisions of this manual.

Scope

II–2. The scope of this RPP covers the transport and storage of radiopharmaceuticals incorporating radioiodines and technetium generators. ABC Radiopharmaceuticals supplies typically 50 000 packages per year to users all over the world. The packages used are, with the exception of a few excepted packages, all of Type A. About 10% of the packages are category III-YELLOW, 30% of the packages are category II-YELLOW, 55% of the packages are category I-WHITE and 5% are excepted packages. The maximum TI encountered is 3.5, and the packages with this TI would be a small fraction of those of category III-YELLOW. ABC Radiopharmaceuticals has a delivery van to transport the packages to the carrier.

Roles and responsibilities

II–3. The RPP would be managed by Mr./Ms. X, who is trained in radiation protection. Mr./Ms. X must ensure that all of the requirements of the RPP are met, including:

(a) Training of workers and implementation of proper work procedures;
(b) Assessment of worker exposures, if necessary by individual monitoring or area monitoring;
(c) Emergency procedures.

II–4. The specific role of the dispatch staff is to verify the following for compliance in respect of each package/shipment:

(a) The description of the material in the shipment (e.g. ^{131}I/^{99}Mo);
(b) The type of packages to be shipped (e.g. Type A);
(c) The activity and isotopes (e.g. ^{131}I: 3.7 GBq);
(d) The shipper's declaration;

(e) Labels on packages providing all required information (TI and category);
(f) The markings on the package;
(g) The certificate of conformance with contamination limits;
(h) Information on action to be taken in the event of an emergency;
(i) Conditions for storage, loading and securing of the packages on to the conveyance.

II–5. The specific role of the driver of the delivery van is to obtain information on the following:

(a) Information on action to be taken in the event of an emergency;
(b) Conditions for storage, loading and securing of the packages on to the conveyance;
(c) The placarding of the conveyance;
(d) Measurements of dose rates around the loaded conveyance.

Dose assessment and optimization

II–6. In order to identify the level of individual potential exposure and to determine the monitoring requirements, ABC Radiopharmaceuticals deployed the services of the firm's radiation specialist (Mr./Ms. Y). The assessment was made on the basis of:

(a) The number and type of packages handled by the firm;
(b) The category of packages and the TI moved;
(c) The radionuclides being shipped;
(d) The frequency of shipment;
(e) The duration of storage prior to transport.

II–7. The study showed that the maximum radiation dose that a cargo handler of ABC Radiopharmaceuticals would receive would be about 3 mSv in a year on the basis of the present work load, while the figure for the driver was 2 mSv and for the acceptance staff 1 mSv. Workplace monitoring would be conducted as determined by the radiation specialist. Dose records would be maintained.

II–8. The area monitors and the contamination monitors recommended by the radiation specialist have been procured and are available to ABC Radiopharmaceuticals for regular use. These monitors are calibrated as recommended by the radiation specialist. Packages, conveyances and the workplace are monitored by Mr./Ms. X to verify the continued validity of the results of the initial dose assessment.

II–9. The dose is kept as low as reasonably achievable by:

(a) Increasing the segregation distances beyond the minimum requirements, where possible;
(b) Minimizing the presence of workers in the vicinity of the packages (i.e. within a distance of 5 m);
(c) Using a trolley to take the packages from the storeroom to the loading area;
(d) Keeping the packages in the shielded bays in the storeroom until as late as possible before loading.

Surface contamination

II–10. The radioactive material to be transported is not in a special form and is carried in appropriate packages in good condition. If damage to packages is suspected, checks for contamination will be made by Mr./Ms. X by taking swabs of the package surface and surrounding areas using the contamination monitors available to ABC Radiopharmaceuticals. Periodic (weekly) checks for contamination are made of the work area and conveyances. Conveyances (or areas of conveyances) that have been used for the transport of radioactive material are checked for contamination before being used for other purposes. The results of the contamination checks would be recorded and retained.

Segregation and other protective measures

II–11. The storage area is 10 m from the office. The office workers are regarded by ABC Radiopharmaceuticals as members of the public. The packages are stored for a maximum of 1 h per day. Therefore, the maximum TI number at this distance would be limited to 10, corresponding to an annual dose of 1 mSv. This is the maximum TI anticipated for present operations. However, the concrete storeroom walls, which are 25 cm thick, provide a dose rate reduction factor of 100, and therefore annual doses are anticipated to be of the order of 10 μSv.

II–12. Where possible all packages, especially the high TI packages, are placed at the rear of the goods compartment when loading the packages on to the vehicle. This will minimize the exposure of the driver.

II–13. The high TI packages would be kept in the storeroom for as long as practicable and would be the last to be loaded. This would reduce the dose to the loaders. Lead shielding of 3 mm thickness is provided behind the driver's cabin of the delivery van.

Emergency response

II–14. In the event of an accident (falling, crushing or fire) during storage or loading of the radioactive consignment on to the vehicle, Mr./Ms. X would implement the following measures:

(a) Take care of people in danger (first aid, emergency medical help);
(b) Assess the risk of, or occurrence of, fire and use the fire extinguisher if appropriate;
(c) Call the radiation specialist for help;
(d) Keep communication lines (telephone lines) open;
(e) With the help of and under the direction of the radiation specialist, clean up the affected area and collect the damaged packages and radioactive waste, if any;
(f) Obtain a certificate from the radiation specialist to confirm that the affected area is safe for normal use again;
(g) Resume operations as normal;
(h) Arrange for the safe disposal of any radioactive waste, as recommended by the radiation specialist;
(i) Inform the competent authority of the incident.

II–15. These instructions are displayed prominently in the storage bay, the vehicle loading area and the vehicle so that, in the absence of Mr./Ms. X, any other responsible person would be able to take these measures.

II–16. Emergency contact details:

Telephone numbers

Person	Office	Residence
Mr./Ms. X	##########	##########
Radiation specialist	##########	##########
Others	##########	##########

Training

II–17. The persons listed below, being employees of ABC Radiopharmaceuticals engaged in the preparation of packages containing radiopharmaceuticals for transport, have received the appropriate training:

Ms. ……………………

Mr. ……………………

Mr. ……………………(Driver/handler)

II–18. They can fulfil the duties assigned in this RPP, namely:

(a) Completion of transport documents;
(b) Preparation of the packages;
(c) Measurements of dose rates and TI;
(d) Completion and application of package labels;
(e) Loading of packages on to the vehicle;
(f) Segregation of packages;
(g) Emergency procedures.

II–19. The training that they have received fulfils the applicable requirements of the competent authority and the policies of ABC Radiopharmaceuticals. They will be subject to retraining every two years.

Management system for procedures and practices

II–20. The RPP is part of the system of management system documents of ABC Radiopharmaceuticals and is subject to all the requirements of the management system for procedures and practices, such as document and version control, document review, issuing and review of instructions and procedures, and follow-up of non-conformances.

II–21. This RPP,

Version No. ………… is approved.

Signature………………., Date: …….

(Name and designation)

Annex III

SPECIFIC EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR AN AIR CARGO CARRIER

III–1. This is an operating manual on the RPP of XYZ Cargo Carriers. The institution undertakes to implement the provisions of this manual.

Scope

III–2. The scope of this RPP covers the transport and storage of packages containing radioactive material. XYZ Cargo Carriers move typically 5000 packages containing Class 7 goods per year to consignees (users) all over the world. The packages carried are of all types, namely excepted packages, Type A and Type B(U)/(M). About 10% of the packages are category III-YELLOW, 30% of the packages are category II-YELLOW, 55% of the packages are category I-WHITE and 5% are excepted packages. The maximum TI encountered is 3.0, and these packages are a small fraction of those of category III-YELLOW. Consignors deliver the packages to the airport cargo office of XYZ Cargo Carriers. This RPP is applicable to all the cargo offices of XYZ Cargo Carriers.

Roles and responsibilities

III–3. The RPP would be managed by Mr./Ms. A, who is trained in radiation protection. Mr./Ms. A must ensure that all of the requirements of the RPP are met, including:

(a) Training of workers and implementation of proper work procedures;
(b) Assessment of worker exposures, if necessary by individual monitoring or area monitoring;
(c) Emergency procedures.

III–4. The specific role of the acceptance staff is to verify the following for compliance in respect of each package/shipment:

(a) The description of the material in the shipment (e.g. ^{131}I/^{99}Mo);
(b) The type of packages to be shipped (e.g. Type A);
(c) The activity and isotopes (e.g. ^{131}I: 3.7 GBq);
(d) The shipper’s declaration;
(e) Labels on packages providing all required information (TI and category);

(f) The markings on the package;
(g) The certificate of conformance with contamination limits;
(h) Information on action to be taken in the event of an emergency;
(i) Conditions for storage, loading and securing of the packages on to the conveyance.

III–5. The specific role of the cargo handlers and the driver is to obtain information on the following:

(a) Information on action to be taken in the event of an emergency;
(b) Conditions for storage, loading and securing of the packages on to the conveyance.

Dose assessment and optimization

III–6. To identify the level of individual potential exposure and to determine monitoring requirements, XYZ Cargo Carriers employed the services of the firm's radiation specialist (Mr./Ms. B). The assessment was made on the basis of:

(a) The number and type of packages handled by the firm;
(b) The category of packages and the TI moved;
(c) The radionuclides being shipped;
(d) The frequency of shipment;
(e) The duration of storage prior to transport.

III–7. The study revealed that the maximum radiation dose that any individual employee of XYZ Cargo Carriers would receive would be less than 1 mSv in a year at the present workload. The radiation specialist recommended neither individual monitoring nor workplace monitoring. The dose records would be maintained. Area monitors and contamination monitors were recommended by the radiation specialist for routine verification of dose rates and emergency response. The area monitors and the contamination monitors recommended by the radiation specialist have been procured and are available to XYZ Cargo Carriers for regular use. These monitors are calibrated as recommended by the radiation specialist. Packages, conveyances and the workplace are monitored by Mr./Ms. A to verify the continued validity of the results of the initial dose assessment.

III–8. The doses are kept as low as reasonably achievable by:

(a) Using a trolley to take the packages from the cargo office to the storage area and the loading area;
(b) Keeping the packages in the storeroom in the shielded bays until as late as possible before loading;
(c) Increasing segregation distances beyond the minimum requirements, where possible;
(d) Minimizing the presence of workers in the vicinity of (within a distance of 5 m from) the packages.

Surface contamination

III–9. The radioactive material to be transported is carried in appropriate packages in good condition. If damage to packages is suspected, checks for contamination will be made by Mr./Ms. A by taking swabs of the package surface and surrounding areas using the contamination monitors available to XYZ Cargo Carriers.

III–10. Periodic (weekly) checks for contamination are made of the work area and the cargo hold, forklift trucks and other loading equipment. The results of the contamination checks would be recorded and retained.

Segregation and other protective measures

III–11. The storage area is 10 m from the office. The office workers are regarded by XYZ Cargo Carriers as members of the public. The packages are stored for a maximum of 3 h per day. The maximum TI number at this distance would be limited to 10, corresponding to an annual dose of 1 mSv. This is the maximum TI anticipated for present operations. However, the concrete storeroom walls, which are 40 cm thick, provide a dose rate reduction factor of 100, and therefore annual doses are anticipated to be of the order of 10 μSv.

III–12. The high TI packages would be kept in the storeroom until as late as practicable and would be the last to be loaded. This would reduce the dose to the loaders. Shielding of 3 mm of lead would be provided in the vehicle behind the driver's cabin.

Emergency response

III–13. In the event of an accident (falling, crushing or fire) during storage or loading of the radioactive consignment on to the aircraft, or upon receipt of information about an accident during taxiing, takeoff, flight or landing, Mr./Ms. A would take the following measures:

(a) Take care of people in danger (first aid, emergency medical help);
(b) Assess the risk of, or occurrence of, fire and use the fire extinguisher if appropriate;
(c) Call the radiation specialist for help;
(d) Inform the concerned airport authority and/or relevant public official;
(e) Keep communication lines (telephone lines) open;
(f) With the help of and under the direction of the radiation specialist, clean up the affected area and collect the damaged packages and radioactive waste, if any;
(g) Obtain a certificate from the radiation specialist to confirm that the affected area is safe for normal use again;
(h) Resume operations as normal;
(i) Arrange for the safe disposal of any radioactive waste, as recommended by the radiation specialist;
(j) Inform the competent authority of the incident.

III–14. These instructions are displayed prominently in the storage bay, the vehicle loading area and the vehicle so that, in the absence of Mr./Ms. A, any other responsible person would be able to implement these measures.

III–15. Emergency contact details:

Telephone numbers

Person	Office	Residence
Mr./Ms. A	##########	##########
Radiation specialist	##########	##########
Others	##########	##########

Training

III–16. The persons listed below, being employees of XYZ Cargo Carriers engaged in the preparation of packages containing radioactive material for transport, have received the appropriate training:

Ms. ……………………

Mr. ……………………

Mr. ……………………

They can fulfil the duties assigned in this RPP, namely:

(a) Checking particulars about the packages before acceptance;
(b) Labelling and marking requirements as per ICAO/International Air Transport Association regulations;
(c) Completion of transport documents;
(d) Measurements of dose rates and TI;
(e) Loading of packages on to the vehicle;
(f) Segregation of packages;
(g) Emergency procedures.

III–17. The training that they have received fulfils the applicable requirements of the competent authority and the policies of XYZ Cargo Carriers. They will be subject to retraining every two years.

Management system for procedures and practices

III–18. The RPP is part of the system of management system documents of XYZ Cargo Carriers, and is subject to all the requirements of the management system for procedures and practices, such as document/version control, document review, issuing and review of instructions and procedures, follow-up of non-conformances, etc.

III–19. This RPP,

Version No. ………… is approved.

Signature………………., Date: …….

(Name and designation)

Annex IV

SPECIFIC EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR AN INDUSTRIAL RADIOGRAPHY INSTITUTION

IV–1. This is an operating manual on the RPP of LMN Industrial Gamma Radiographers. The institution undertakes to implement the provisions of this manual.

Scope

IV–2. The scope of this RPP covers the transport and storage of gamma radiography sources duly housed in their approved shielded containers/devices. LMN Industrial Gamma Radiographers transports its own gamma radiography devices once a month. The packages used are all of Type B(U) and are currently approved by the competent authority. A complete list of the gamma radiography devices in the possession of LMN Gamma Radiographers will be provided by the firm to the competent authority as and when required. Almost all the packages transported by the firm are category III-YELLOW. The maximum TI encountered is 1.0. LMN Industrial Gamma Radiographers has a delivery van that transports the packages to the carrier or to the radiography sites.

Roles and responsibilities

IV–3. The RPP would be managed by Mr./Ms. X, who is trained in radiation protection. Mr./Ms. X must ensure that all of the requirements of the RPP are met, including:

(a) Training of workers and implementation of proper work procedures;
(b) Assessment of worker exposures, if necessary by individual monitoring or area monitoring;
(c) Emergency procedures.

IV–4. The specific role of the radiographer is to verify the following for compliance in respect of each package/shipment:

(a) That the radiography source is duly housed in the appropriate shielded container prior to despatch;
(b) The description of the material in the shipment (e.g. ^{192}Ir);

(c) The type of packages to be shipped (e.g. Type B(U));
(d) The activity and isotopes (e.g. ^{192}I: 1.8 TBq);
(e) The shipper's declaration;
(f) Labels on packages providing all required information (TI and category);
(g) The markings on the package;
(h) Information on action to be taken in the event of an emergency;
(i) Conditions for storage, loading and securing of the packages on to the conveyance.

IV–5. The specific role of the driver of the delivery van is to obtain information on the following:

(a) Action to be taken in the event of an emergency;
(b) Conditions for storage, loading and securing of the packages on to the conveyance;
(c) Placarding of the conveyance;
(d) Measurements of dose rates around the loaded conveyance.

IV–6. Frequently, loading the device on to the vehicle and also driving the vehicle are the responsibilities of the radiographer.

Dose assessment and optimization

IV–7. To identify the level of individual potential exposure and to determine monitoring requirements, LMN Industrial Gamma Radiographers deployed the services of the firm's radiation specialist (Mr./Ms. Y). The assessment was made on the basis of:

(a) The number and type of packages handled by the firm;
(b) The category of packages and the TI moved;
(c) The radionuclides being shipped;
(d) The frequency of shipment;
(e) The duration of storage prior to transport.

IV–8. The study showed that, since the radiographer would often act as the cargo handler, the maximum individual radiation dose that he or she would receive would be at least 6 mSv in a year at the present work load. Individual monitoring would be conducted as determined by the radiation specialist. Dose records would be maintained.

IV–9. The area monitors and the individual dosimeters recommended by the radiation specialist have been procured and are regularly used. The area monitors are calibrated as recommended by the radiation specialist. Packages, conveyances and the workplace are monitored by Mr./Ms. X to verify the continued validity of the results of the initial dose assessment.

IV–10. The dose is kept as low as reasonably achievable by:

(a) Using a trolley to take the packages from the storeroom to the loading area;
(b) Keeping the packages in the storeroom in the shielded bays until as late as possible before loading;
(c) Increasing segregation distances beyond the minimum requirements, where possible;
(d) Minimizing the presence of workers in the vicinity of (within a distance of 5 m from) the packages.

Surface contamination

IV–11. The radioactive material to be transported is in special form and carried in appropriate packages in good condition. If damage to packages is suspected, checks for shielding integrity will be made by Mr./Ms. X. Periodic (weekly) radiation protection surveys are made of the work area and conveyances. The results of the radiation checks would be recorded and retained.

Segregation and other protective measures

IV–12. The storage area is 10 m from the office. The office workers are regarded by LMN Industrial Gamma Radiographers as members of the public. The packages are stored for a maximum of 8 h per day. Not more than five packages would be stored in this area. The storage is always in an underground pit provided with sufficient shielding to ensure that the radiation level outside the pit is no more than 0.1 μSv/h. The occupancy in the immediate vicinity of the pit would be occasional.

IV–13. Where possible, all packages, especially the high TI packages, are placed at the rear of the goods compartment when loading the packages on to the vehicle. This will minimize the exposure of the driver.

IV–14.The packages would be kept in the storeroom for as long as practicable and would be the last to be loaded. This would reduce the dose to the loader.

Lead shielding of 3 mm thickness is provided behind the driver's cabin of the delivery van.

Emergency response

IV–15. In the event of an accident (falling, crushing or fire) during storage or loading of the radioactive consignment on to the vehicle, Mr./Ms. X would take the following measures:

(a) Take care of people in danger (first aid, emergency medical help);
(b) Assess the risk of, or occurrence of, fire and use the fire extinguisher if appropriate;
(c) Call the radiation specialist for help;
(d) Keep communication lines (telephone lines) open;
(e) With the help of and under the direction of the radiation specialist, clean up the affected area and collect the damaged packages and radioactive waste, if any;
(f) Obtain a certificate from the radiation specialist to confirm that the affected area is safe for normal use again;
(g) Resume operations as normal;
(h) Arrange for the safe disposal of any radioactive waste, as recommended by the radiation specialist;
(i) Inform the competent authority of the incident.

IV–16. These instructions are displayed prominently in the storage bay, the vehicle loading area and the vehicle so that, in the absence of Mr./Ms. X, any other responsible person would be able to take these measures.

IV–17. Emergency contact details:

Telephone numbers

Person	Office	Residence
Mr./Ms. X	##########	##########
Radiation specialist	##########	##########
Others	##########	##########

Training

IV–18. The persons listed below, being employees of LMN Industrial Gamma Radiographers engaged in the preparation of packages containing radiopharmaceuticals for transport, have received the appropriate training:

Ms. ……………………

Mr. ……………………(Radiographer)

Mr. ……………………(Driver/handler)

They can fulfil the duties assigned in this RPP, namely:

(a) Completion of transport documents;
(b) Preparation of the packages;
(c) Measurements of dose rates and TI;
(d) Completion and application of package labels;
(e) Loading of packages on to the vehicle;
(f) Segregation of packages;
(g) Emergency procedures.

IV–19. The training that they have received fulfils the applicable requirements of the competent authority and the policies of LMN Industrial Gamma Radiographers. They will be subject to retraining every two years.

Management system for procedures and practices

IV–20. The RPP is part of the system of management system documents of LMN Industrial Gamma Radiographers and is subject to all the requirements of the management system for procedures and practices, such as document/version control, document review, issuing and review of instructions and procedures, follow-up of non-conformances, etc.

IV–21. This RPP,

Version No. ………… is approved.

Signature………………, Date: …….

(Name and designation)

Annex V

SPECIFIC EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR PUBLIC AUTHORITIES

V–1. This example of an RPP is applicable to the following public authorities:

(a) Airport authorities;
(b) Harbour/port authorities;
(c) Customs authorities;
(d) Modal authorities (civil aviation, rail, road and sea transport).

Scope

V–2. Package: All packages containing radioactive material; namely industrial packages, Type IP-1, 2 and 3, Type A and Type B(U) and B(M) packages.

Roles and responsibilities

V–3. The authority hereby designates Mr./Ms. X as the person who will monitor the implementation of:

(a) Requirements for ensuring the smooth carriage of radioactive cargo;
(b) Requirements for training of personnel;
(c) Dose assessment;
(d) Emergency response.

Facilitating the carriage of radioactive cargo

V–4. Mr./Ms. X will ensure that the handling of radioactive cargo is facilitated, provided that such cargo has been forwarded in compliance with the applicable regulations for the safe transport of radioactive material.

Training of personnel

V–5. Mr./Ms. X:

(a) Has received the basic training relating to dangerous goods, including radioactive cargo;
(b) Is aware of the rudiments of regulatory requirements;

(c) Is capable of recognizing labels for different types of dangerous cargo, reporting incidents and acting as directed by experts in the event of an emergency.

Dose assessment

V–6. Dose assessment of employees of the public authority by monitoring is not required because doses to workers and the public are limited by pre-established segregation and the limitation of access to the radioactive cargo.

Emergency response

V–7. Mr./Ms. X will ensure that emergency preparedness is in compliance with the relevant international or national emergency response requirements.

Documentation

V–8. Documents to be maintained by Mr./Ms. X include particulars relating to (a) the consignee/licensee, if the cargo is off-loaded; (b) the radioactive cargo permitted to be off-loaded and to remain on board in transit; (c) instances of denial of permission for carriage or transit of radioactive cargo; and (d) reasons for such denial.

Management system for procedures and practices

V–9. A management system that is capable of evaluating the implementation of the procedures and practices is established. The RPP is part of the system of management system documents of this organization and is subject to all the requirements of the management system for procedures and practices, such as document/version control, document review, issuing and review of instructions and procedures, follow-up of non-conformances, etc.

V–10. This RPP,

Version No. ………… is approved.

Signature………………, Date: …….

(Name and designation)

Annex VI

EVALUATION OF RADIATION PROTECTION PROGRAMMES

PART 1: DETAILED CHECKLIST FOR EVALUATING A RADIATION PROTECTION PROGRAMME

1. Company:……………………………………………………………………

2. Does the company operate under a valid licence (if applicable)?
YES…… NO……

3. Expiry date……………………………………………………………………

4. The scope of the RPP covers the following procedures:
Packaging…… Transport…… Storage…… Other (specify)……
(Tick as appropriate)

5. Is there a brief description of the operations?
YES…… NO……

6. Who is the person assigned by the company having overall responsibility for the RPP?
……………………………………………………………………………………

7. Are his/her qualifications indicated (described)?
YES…… NO……

8. Is he/she accepted as a suitably qualified person?
YES…… NO……
Describe qualifications/experience:…………………………………………

9. Is he/she responsible for ensuring the following?
   9.1 Training of workers
   YES…… NO……
   If NO, who is responsible?……………………………………………
   9.2 Implementation of proper work procedures
   YES…… NO……
   If NO, who is responsible?……………………………………………
   9.3 Assessment of workers' exposures
   YES…… NO…….

If NO, who is responsible?…………………………………………….

9.4 Emergency procedures
YES…… NO……
If NO, who is responsible?……………………………………………

10. Are other workers appointed to fulfil duties relevant to the RPP?
YES…… NO…….
If YES, provide the necessary information in the following table:

NAME	ACTIVITIES	TRAINING	COMMENTS

11. Have dose assessments been carried out:
YES…… NO……

12. Indicate the assumptions used for the dose assessment described in the RPP:
— Number of packages:……………………………………………………
— Type of packages:……………………………………………………..
— Category of packages:………………………………………………..
— Maximum total TI:……………………………………………………
— Radionuclides:…………………………………………………………
— Frequency of shipment:………………………………………………
— Duration of storage:………………………………………………….
— Duration of transport:………………………………………………..

13. Workers' categories (e.g. drivers, cargo handlers, etc.):
1………… 2………… 3…………. 4………….. 5…………..

14. Dose assessment of each category (mSv in a year, μSv in a year):
1………… 2………… 3…………. 4………….. 5…………..
Accepted:………. More work needed:………… Not accepted:………
Recommendations:…………………………………………………..…

15. Indicate number of workers individually monitored:…………………….

16. Are there any workplaces subject to area monitoring?
YES…… NO……
Describe:………………………………………………………………...

17. Are dose records relating to items 15 and 16 kept?
YES…… NO…… Not required………..

18. Are appropriate separation distances used between packages and areas regularly occupied by members of the public?
YES…… NO…… Describe:……………..

19. Are appropriate separation distances used between packages and areas regularly occupied by workers?
YES…… NO…… Describe:……………..

20. Are shielded areas used in the storage?
YES…… NO…… Describe:……………..

21. Is shielding used on the conveyances?
YES…… NO……
Describe (specify material used and thickness):………………………….

22. Is segregation used on the conveyances?
YES…… NO…… Describe:……………..

23. How are the packages transported from storage to the loading area?
Describe:…………………………………………………………………….
Accepted:……….More work needed:…………Not accepted:…………
Recommendations:……………………………………………………........

24. How are the packages transferred from the conveyance to the final destination?
Describe:……………………………………………………………………..
Accepted:……….More work needed:…………Not accepted:…………
Recommendations:……………………………………………………......

25. Are contamination checks performed?
YES…… NO……
— Describe method:……………………….
— By whom:……………………….……....
— Frequency:……………………….……...
— Location:…………………………........

26. Are contamination check records kept?
YES…… NO……

27. Are other protective measures used for dose reduction for workers:
YES…… NO…… Describe:……………..

28. Are emergency procedures in place?
YES…… NO……
Accepted:………. More work needed:………… Not accepted: ………
Recommendations:……………………………………………………….

29. Is the necessary emergency information in place on the conveyance?
YES…… NO…… Describe:……………..

30. Is the necessary emergency information in place in the storage area?
YES…… NO…… Describe:……………..

31. Is the necessary emergency information in place in the packaging area?
YES…… NO…… Describe:……………..

32. Tick the worker categories (as identified in item 13) that have been trained:
1……….. 2……….. 3………… 4………….. 5…………..

33. Who performed the training for the above mentioned worker categories?
1……….. 2……….. 3………… 4………….. 5…………..

34. Is the training programme approved by the appropriate competent authority (if applicable)?
YES…… NO……. Describe:……………..

35. Specify the frequency of training revalidation: ……………………………

Conclusions/remarks:……………………………………………………………..
…………………………………………………………………

Company representative…………… Competent authority inspector………….
…………………………………. Date and place: ………………………………....

PART 2: QUESTIONNAIRE FOR EVALUATING THE EFFECTIVENESS OF THE RADIATION PROTECTION PROGRAMME

- How does the RPP fit within the general management system?
- Does the scope of the RPP reflect completely and accurately what the RPP should cover?
- Is the management commitment sufficiently demonstrated?
  - Are the resources (human and technical) available to fulfil the objectives of the RPP?
- Are the roles and responsibilities of all workers concerned adequately described and fully outlined?
  - Has the dose assessment of the workers in different workplaces been carried out correctly? And is it still valid?
- Has this assessment been validated and/or verified through, for example, periodic checks or workplace dose verification?
- Are the personnel involved in the different actions sufficiently and correctly trained and familiar with equipment and instruments (including those that are not routinely used)?
  - Is the training correctly documented (certificates, expiry dates, etc.)?
- If applicable (e.g. to consignors): Are the decisions on classification (UN number, proper shipping name), package requirements (using the correct and optimized package design), labelling, etc., taken by sufficiently skilled personnel, verified and properly documented and recorded?
  - Are the necessary approvals and certificates in place and valid?
- Are there working instructions and procedures in place (and implemented by the workers) that give clear and adequate guidance to ensure the maximum efficiency and to minimize doses?
  - Are these instructions and procedures up to date and consistent with the objectives of the RPP?
  - Do they cover all aspects, including emergency procedures?
- Is the measuring equipment (for dose rate, contamination and air monitoring if required) adequate for the measurements to be taken?
  - Are calibration certificates in place and valid for the task to be done?
  - Are the proper user instructions followed?
  - Are the results of measurements recorded?

Annex VII

EXCERPTS FROM THE IAEA REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL, 2005 EDITION, IAEA SAFETY STANDARDS SERIES No. TS-R-1

DEFINITIONS

“*Radiation Protection Programme*

“234. *Radiation Protection Programme* shall mean systematic arrangements which are aimed at providing adequate consideration of radiation protection measures.”

GENERAL PROVISIONS

“RADIATION PROTECTION

“301. Doses to persons shall be below the relevant dose limits. Protection and safety shall be optimized in order that the magnitude of individual doses, the number of persons exposed, and the likelihood of incurring exposure shall be kept as low as reasonably achievable, economic and social factors being taken into account, within the restriction that the doses to individuals be subject to dose constraints. A structured and systematic approach shall be adopted and shall include consideration of the interfaces between transport and other activities.

“302. A *Radiation Protection Programme* shall be established for the transport of *radioactive material*. The nature and extent of the measures to be employed in the programme shall be related to the magnitude and likelihood of radiation exposures. The programme shall incorporate the requirements of paras 301, 303–305, 311 [and 563]. Programme documents shall be available, on request, for inspection by the relevant *competent authority*.

“303. For occupational exposures arising from transport activities, where it is assessed that the effective dose:

(a) is likely to be between 1 and 6 mSv in a year, a dose assessment programme via workplace monitoring or individual monitoring shall be conducted;

(b) is likely to exceed 6 mSv in a year, individual monitoring shall be conducted.

When individual monitoring or workplace monitoring is conducted, appropriate records shall be kept."

"COMPLIANCE ASSURANCE

"308. The *competent authority* shall arrange for periodic assessments of the radiation doses to persons due to the transport of *radioactive material*, to ensure that the system of protection and safety complies with the Basic Safety Standards…"

"TRANSPORT AND STORAGE IN TRANSIT

"Segregation during transport and storage in transit

"563. *Packages*, *overpacks* and *freight containers* containing *radioactive material* and unpackaged *radioactive material* shall be segregated during transport and during storage in transit:

(a) from workers in regularly occupied work areas by distances calculated using a dose criterion of 5 mSv in a year and conservative model parameters;
(b) from members of the critical group of the public, in areas where the public has regular access, by distances calculated using a dose criterion of 1 mSv in a year and conservative model parameters;
(c) from undeveloped photographic film by distances calculated using a radiation exposure criterion for undeveloped photographic film due to the transport of *radioactive material* of 0.1 mSv per *consignment* of such film; and
(d) from other dangerous goods in accordance with para. 506."

"TRAINING

"311. Workers shall receive appropriate training concerning radiation protection including the precautions to be observed in order to restrict their occupational exposure and the exposure of other persons who might be affected by their actions.

"312. Persons engaged in the transport of *radioactive material* shall receive training in the contents of these Regulations commensurate with their responsibilities.

"313. Individuals such as those who classify *radioactive material*; pack *radioactive material*; mark and label *radioactive material*; prepare transport documents for *radioactive material*; offer or accept *radioactive material* for transport; carry or handle *radioactive material* in transport; mark or placard or load or unload packages of *radioactive material* into or from transport *vehicles*, bulk *packagings* or *freight containers*; or are otherwise directly involved in the transport of *radioactive material* as determined by the *competent authority*; shall receive the following training:

"(a) General awareness/familiarization training:
   - (i) Each person shall receive training designed to provide familiarity with the general provisions of these Regulations;
   - (ii) Such training shall include a description of the categories of *radioactive material*; labelling, marking, placarding and *packaging* and segregation requirements; a description of the purpose and content of the *radioactive material* transport document; and a description of available emergency response documents;

(b) Function specific training: Each person shall receive detailed training concerning specific *radioactive material* transport requirements which are applicable to the function that person performs;

(c) Safety training: Commensurate with the risk of exposure in the event of a release and the functions performed, each person shall receive training on:
   - (i) Methods and procedures for accident avoidance, such as proper use of package handling equipment and appropriate methods of stowage of *radioactive material*;
   - (ii) Available emergency response information and how to use it;
   - (iii) General dangers presented by the various categories of *radioactive material* and how to prevent exposure to those hazards, including if appropriate the use of personal protective clothing and equipment; and
   - (iv) Immediate procedures to be followed in the event of an unintentional release of *radioactive material*, including any

emergency response procedures for which the person is responsible and personal protection procedures to be followed."

"314. The training required in para. 313 shall be provided or verified upon employment in a position involving *radioactive material* transport and shall be periodically supplemented with retraining as deemed appropriate by the *competent authority*."

"EMERGENCY RESPONSE

"304. In the event of accidents or incidents during the transport of *radioactive material*, emergency provisions, as established by relevant national and/or international organizations, shall be observed to protect persons, property and the environment. Appropriate guidelines for such provisions are contained in Ref. [4[1]].

"305. Emergency procedures shall take into account the formation of other dangerous substances that may result from the reaction between the contents of a *consignment* and the environment in the event of an accident."

[1] Note that Ref. [4] of the Transport Regulations is INTERNATIONAL ATOMIC ENERGY AGENCY, Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material, IAEA Safety Standards Series No. TS-G-1.2 (ST-3), IAEA, Vienna (2002).

Annex VIII

EXAMPLES OF TOTAL DOSE PER TRANSPORT INDEX

TABLE VIII–1. EXAMPLES OF TOTAL DOSE PER TRANSPORT INDEX

Type of transport		Number of workers	Total TI handled	Total dose received (mSv)	Total dose/TI (μSv/TI)	Ref.
UK transport	Road	350	70 000	220	3.1	[VIII–1]
USA transport of radiopharmaceuticals	Road	6	11 750	3.0	1.1	[VIII–2]
	Road	6	12 430	18.2	1.5	
	Road	6	12 766	19.8	1.5	
	Road	6	12 621	19.3	1.5	
	Road	6	12 418	22.5	1.8	
	Road	6	15 049	20.4	1.4	
	Air	371	49 174	115	2.3	
	Road	134	80 000	149	1.9	
	Road	133	80 000	158	2.0	
	Road	128	80 000	145	1.8	
	Road	120	80 000	145	1.8	
	Road	9	2 612	1.65	0.6	
	Road	10	2 696	1.95	0.7	
	Road	16	3 453	6.95	2.0	

REFERENCES TO ANNEX VIII

[VIII–1] WATSON, S.J., OATWAY, W.B., JONES, A.L., HUGHES, J.S., Survey into the Radiological Impact of the Normal Transport of Radioactive Material in the UK by Road and Rail, Rep. NRPB-W66, National Radiological Protection Board, Chilton, UK (2005).

[VIII–2] SHAPIRO, J., Exposure of Airport Workers to Radiation from Shipments of Radioactive Materials: A Review of Studies Conducted at Six Major Airports, Rep. NUREG-0154, United States Nuclear Regulatory Commission, Washington, DC (1977).

Annex IX

SEGREGATION REQUIREMENTS FOR MARITIME TRANSPORT RADIATION PROTECTION[1]

7.2.9 Segregation for goods of class 7

7.2.9.1 Radioactive material should be segregated sufficiently from crew and passengers. The following values for dose should be used for the purpose of calculating segregation distances or radiation levels:

(a) for crew in regularly occupied working areas, a dose of 5 mSv in a year;
(b) for passengers, in areas where the passengers have regular access, a dose of 1 mSv in a year to the critical group.

7.2.9.3 Category II-YELLOW or III-YELLOW packages or overpacks should not be transported in spaces occupied by passengers, except those exclusively reserved for couriers specially authorized to accompany such packages or overpacks.

7.2.9.6 Any departure from the segregation provisions should be approved by the competent authority of the flag State of the ship and, when requested, by the competent authority at each port of call.

7.2.9.7 The segregation requirements specified in 7.2.9.1. may be established in one of the following two ways:

— By following the segregation tables (I and III hereafter) in respect of living quarters or spaces regularly occupied by persons. Table III includes comprehensive provisions which are of general applicability. Table I provides simplified information which is applicable to certain ship sizes, or
— By demonstration that, for the following indicated exposure times, the direct measurement of the radiation level in regularly occupied spaces and living quarters is less thanfor the crew:

0.0070 mSv/h up to 700 hours in a year, or

[1] Taken from INTERNATIONAL MARITIME ORGANIZATION, International Maritime Dangerous Goods Code, 2000 Edition, Including Amendments 30-00, IMO, London (2004).

0.0018 mSv/h up to 2750 hours in a year; and
for the passengers:
0.0018 mSv/h up to 550 hours in a year,
taking into account any relocation of cargo during the voyage. In all cases, the measurements of radiation *level* must be made and documented by a suitably qualified person.

TABLE I. CLASS 7 — RADIOACTIVE MATERIAL
(simplified segregation table for persons)

Sum of transport indices (TI)	Segregation distance of radioactive material from passengers and crew			
	General cargo ship [1]		Ferry, etc. [2]	Offshore support vessel [3]
	Break-bulk (m)	Containers (TEUs) [4]		
Up to 10	6	1	Stow at bow or stern furthest from living quarters and regularly occupied work areas	Stow at stern or at platform midpoint
More than 10 but not more than 20	8	1	As above	As above
More than 20 but not more than 50	13	2	As above	Not applicable
More than 50 but not more than 100	18	3	As above	Not applicable
More than 100 but not more than 200	26	4	As above	Not applicable
More than 200 but not more than 400	36	6	As above	Not applicable

[1] General cargo, break-bulk or ro-ro container ship of 150 m minimum length.
[2] Ferry or cross-channel, coastal and inter-island ship of 100 m minimum length.
[3] Offshore support vessel of 50 m minimum length. (In this case the practical maximum sum of TIs carried is 20.)
[4] TEU means '20 ft equivalent unit' (this is equivalent to a standard freight container of 6 m nominal length).

TABLE III. CLASS 7 — RADIOACTIVE MATERIAL

(segregation table in metres: safe distances for persons and undeveloped photographic films and plates)

Cargo thickness (unit density) / Sum of transport indices (Note (7))	Minimum distance in metres from living quarters or spaces regulary occupied by persons		Minimum distance in metres from undeveloped films and plates: 1 day voyage			2 day voyage			4 day voyage			10 day voyage			20 day voyage			30 day voyage			40 day voyage			50 day voyage		
	Nil	1	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2
0.5	2	X	2	X	X	3	X	X	4	X	X	6	2	X	8	2	X	10	3	X	11	3	X	12	3	X
1	2	X	3	X	X	4	X	X	5	2	X	8	2	X	11	3	X	13	4	X	15	4	X	17	4	X
2	3	X	4	X	X	5	2	X	7	2	X	11	3	X	15	4	X	19	5	X	22	5	X	24	6	X
3	4	X	5	X	X	6	2	X	9	2	X	13	4	X	19	5	X	23	6	X	27	7	X	30	7	X
5	4	X	6	2	X	8	2	X	11	3	X	17	4	X	24	6	X	30	7	X	34	8	X	38	9	3
10	6	2	8	2	X	11	3	X	15	4	X	24	6	X	34	8	X	42	10	3	48	12	3	54	13	3
20	8	2	11	3	X	15	4	X	22	5	X	34	8	X	48	12	3	59	14	4	68	16	4	76	18	5
30	10	3	13	4	X	19	5	X	26	7	X	42	10	3	59	14	4	72	17	4	83	20	5	93	22	6
50	13	3	17	4	X	24	6	X	34	8	X	54	13	3	76	18	5	92	23	6	110	26	7	120	29	7
100	18	5	24	6	X	34	8	X	48	12	3	76	18	5	110	25	6	130	32	8	150	36	9	170	40	10
150	22	6	30	7	X	42	10	3	59	14	4	93	22	6	130	31	8	160	39	10	185	45	11	•	50	12
200	26	6	34	8	X	48	12	3	68	16	4	110	26	7	150	36	9	185	43	11	•	51	13	•	58	14
300	32	8	42	10	3	59	14	4	83	20	5	130	32	8	185	44	11	•	55	13	•	63	15	•	70	17
400	36	9	48	12	3	68	16	4	95	23	6	150	36	9	•	50	13	•	63	15	•	73	18	•	81	20

Notes:

(1) X indicates that thickness of screening cargo is sufficient without any additional segregation distance.
(2) By using 2 m of intervening unit density cargo for persons, and 3 m for films and plates, no distance shielding is necessary for any length of voyage specified.
(3) Using one steel bulkhead or steel deck — multiply segregation distance by 0.8. Using two steel bulkheads or steel decks — multiply segregation distance by 0.64.
(4) ‘Cargo of unit density’ means cargo stowed at a density of 1 tonne per m^3; where the density is less than this, the depth of cargo specified must be increased in proportion.
(5) ‘Minimum distance’ means the least distance in any direction, whether vertical or horizontal, from the outer surface of the nearest package.
(6) The figures below the double line of the table should be used in those cases where the appropriate provisions of this class permit the total transport index to exceed 200.
(7) Transport indices of packages, overpacks, freight containers and tanks, as appropriate.
• Not to be carried unless screening by other cargo and bulkheads can be arranged in accordance with the other columns.

Annex X

EXAMPLE OF CHECKLIST FOR ROAD TRANSPORT[1]

TRANSNUBEL Gravenstraat, 73 B – 2480 Dessel	TRANSPORT OF RADIOACTIVE MATERIALS CHECK LIST RADIOPROTECTION SERVICE

File n°	:
Date, place and hour of departure	:
Date, place and hour of arrival	:
TNB agent, responsible for the verification	:
Name of the drivers and their employer	:

1. *Verification concerning Radioactive Contents*			
1.1. Contamination of the vehicle	Measured ☐	Not measured ☐	
1.2. Dose rate (μSv/h)	Estimated/mentioned	Measured	Measuring instr. n°
■ in contact with the package			
■ near the vehicle			
■ at 1 m distance from the vehicle			
■ at 2 m distance from the vehicle			
■ drivers cabin			
1.3. Verification labels on package (or freight container)	WHITE I	YELLOW II	YELLOW III
1.4. Transport index			
1.5 Criticality Safety Index			
1.6. Information on the labels			

2. *Verification of the vehicle (general and ADR)*				
2.1. Licence plate	Truck		Semi-trailer	
2.2. Signs ADR and ADR7	Front	At the back	Right	Left
2.3. Visual verification vehicle and equipment				
Conform			Yes ☐	No
2.4. Verification driver's documents			1st driver	2nd driver
■ driver's licence				
■ attestation ADR and ADR7				

3. *Verification of equipment (as required by C.A.)*	
3.1. Two portable fire extinguishers	
3.2. Repair kit/chocks	
3.3. Two independent blinkers	
3.4. Locker loading space	
3.5. Stowing of the package	
4. *Verification of the documents accompanying the convoy*	
4.1. Verification of the transported material with the information on the transport application form (CMR or equivalent)	
4.2. Certificate of approval for the package	
4.3. Nuclear liability insurance	
4.4. Working instruction n° 69 : actions to be taken in case of incident or accident, telephone list, safety instructions	

Date :	Name :	Signature :

[1] Based upon a checklist provided by Transnubel, Belgium.

TRANSNUBEL Gravenstraat, 73 B – 2480 Dessel	TRANSPORT OF RADIOACTIVE MATERIALS CHECK LIST RADIOPROTECTION SERVICE

5. Report about an incident, anomaly or supposed default

Ref.	Description	Actions taken

6. Final decision: Yes/No

Maximum measured values package:		contact	:	2 mSv/h = 2.000 µSv/h
		at 1 m	:	0,1 mSv/h = 100 µSv/h
Maximum measured values vehicle	:	at 2 m	:	100 µSv/h
		in contact	:	2 mSv/h = 2.000 µSv/h

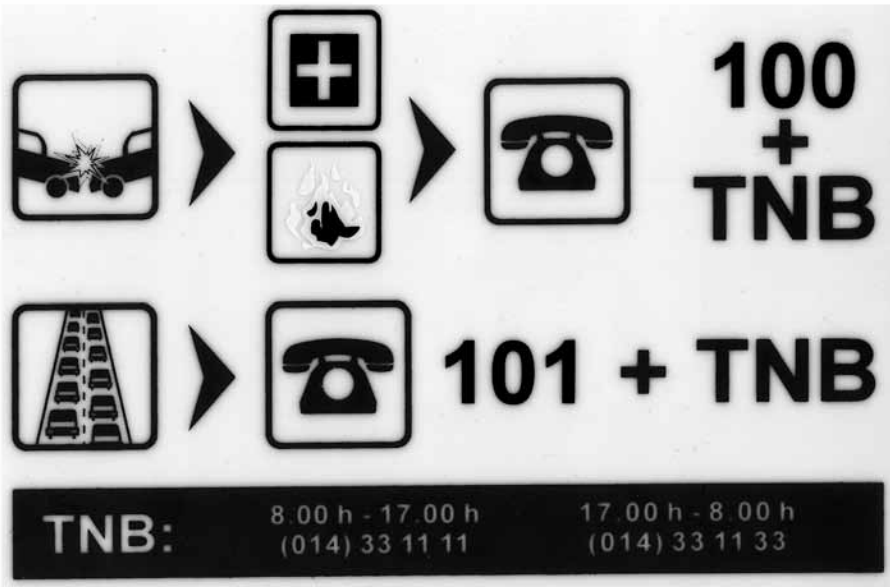
THESE VALUES MAY NOT BE EXCEEDED !

DIFFUSION : ORIGINAL → TRANSPORT FILE - 1 COPY → HEAD OF DEPARTMENT

Annex XI

EXAMPLE RADIATION PROTECTION AND EMERGENCY RESPONSE INSTRUCTIONS FOR A VEHICLE OPERATOR[1]

XI–1. A card with pictogrammes and supplementary written information in different languages may be helpful in facilitating radiation protection measures during the transport of radioactive material, especially in the event of accidents or unexpected delays. An example of such communication tools is provided here; these are used by Transnubel of Belgium for road transport in Europe.



[1] Provided by Transnubel, Belgium.

NOTE: The following pages present examples that are not intended for direct use: The content and the language of the different examples reflect the local regulations and prescriptions at the end of 2000; they should be updated (e.g. telephone numbers should be verified) before actual use.

B E L G I E / B E L G I Q U E

IN GEVAL VAN ONGEVAL
EN CAS D'ACCIDENT

1. **Dringend** telefoneren naar / Appelez d'urgence

   100 (wanneer er gewonden zijn of er gevaar is voor brand)
   (lorsqu'il y a des blessés ou un danger d'incendie)

   101 (bij verkeersproblemen)
   (lors de problèmes de circulation)

2. **Gedurende de diensturen** / Jours et heures ouvrables

   TRANSNUBEL (014) 33 11 11

   Buiten de diensturen/ Jours et heures non ouvrables

   TRANSNUBEL (014) 33 11 33

NEDERLAND

DIT VOERTUIG VERVOERT RADIOACTIEVE STOFFEN

KORPS LANDELIJKE POLITIEDIENSTEN
TEL : 0343514681
of 0343535353

ALARMNUMMER : 112

TRANSNUBEL :

gedurende de diensturen	:	00 32 14 33 11 11
buiten de diensturen	:	00 32 14 33 11 33

UNITED KINGDOM

THIS VEHICLE IS CARRYING RADIOACTIVE MATERIALS

In case of accident, please get in touch at once with

- **the Local Police,**
- **the Force Communications Center of AEA**
  TEL : 01925-630345
- **Transnubel/Dessel**
  during working hours TEL : 010 32 14 33 11 11
  out of working hours TEL : 010 32 14 33 11 33

FRANCE

ATTENTION, CE VEHICULE TRANSPORTE DES MATIERES RADIOACTIVES

EN CAS D'ACCIDENT PREVENIR :

1) La gendarmerie ou le commissariat de police le plus proche.

2) L'Echelon Opérationnel des Transports (EOT) :

heures ouvrables	:	(1) 46 54 74 95
en dehors des heures ouvrables	:	(1) 46.57.02.53
		(1) 46.38.34.91

3) Transnubel :

heures ouvrables	:	00 32 14.33.11.11
en dehors des heures ouvrables	:	00 32 14 33.11.33

DEUTSCHLAND

IM FALL EINES UNFALLS

BITTE BENACHRICHTIGEN SIE SOFORT :

- **Transnubel Dessel Belgien** — 00 32 14 33 11 11
- **NCS GmbH**
  - während Dienstzeit — 061 31 20 49 70
  - außerhalb Dienstzeit — Mobiltelefon 0171 561 00 47 oder Cityruf 016951 605 74 53

SCHWEIZ

BEI EINEM UNFALL

1. **SCHWEIZERISCHE POLIZEI**
   Tel : 117

   ARMA
   044/251.60.88

2. **NATIONALE ALARMZENTRALE FÜR UNFÄLLE**
   Tel : 044/251 60 88

3. **DIE BEHÖRDEN**

- *Bundesamt für Energie*
  Hauptabteilung für die Sicherheit der Kernanlagen
  CH - 5232 VILLIGEN - HSK
  Tel : 056/310 39 94

- *Bundesamt für Energie*
  CH - BERN
  Herr BRUDER
  Tel : 031/322 56 67
  Herr WIELAND
  Tel : 031/322 56 47

JAPAN

放射性輸送物を運搬するために

1. 種　　類：A型輸送物　　核種＿＿＿＿＿　　数量＿＿＿＿＿＿

2. 積載時の注意：●運搬中において、移動、転倒、転落等により、放射性輸送物の安全性が損なわれないよう積載すること。
●火薬類、高圧ガス等他の危険物と混載しないこと。
●1 車両に積載する輸送指数の合計が 50 を超えないこと。
●車両の両側面及び後部に車両標識(右記参照)を付けること。
●夜間は車両の前部及び後部に赤色燈を点燈すること。

3. 取扱いの注意：●関係者以外の者が通常立入る場所で積込み、取卸しをしないこと。
●非開放型の車両に施錠等の措置がなされている場合を除き、運搬の途中駐車するときは見張人を配置すること。

4. 事故時の措置：●交通事故等で積荷に異常が生じた場合は、最寄りの警察署に通報すること。
●車両火災が発生した場合は、備え付けの消火器で消火するとともに、最寄りの消防署に通報すること。
●盗難、紛失、その他の事故が発生した場合は、最寄りの警察署に通報すること。

以上の措置をとるとともに、出来るだけ早く、社団法人日本アイソトープ協会業務二課に、ご連絡下さい(電話：03-5395-8031　休日・夜間の電話：03-3946-6305)。

JAPAN

To Carry Radioactive Packages

1. Type : Type A package   Nuclide ________   Quantity ________
2. Attention during loading and transport:
   - In preparation for the transport of radioactive material, load the package so that its safety during transport will not be compromised by movement, tumbling, falling, etc.
   - Don't consolidate with other dangerous substances such as explosives, high-pressure gas.
   - Assure that the total transport index loaded on one vehicle doesn't exceed 50.
   - Affix the placards (see the figure on the right) to both sides and the rear of the vehicle.
   - While in transport at night, turn on the red lights at the front and the rear of the vehicle.

3. Attention during handling :
   - Loading and unloading should only be done in areas where the presence of members of the public is not authorized.
   - If the driver must leave the vehicle when parked along the transport route, except for the case where the vehicle can be locked or otherwise made inaccessible, arrange for the presence of a watchkeeper.
4. Action in case of an accident :
   - When the consignment is compromised because of a traffic accident or similar, report to the nearest police station.
   - When a vehicle fire occurs, extinguish it with the extinguisher from the vehicle, and report to the nearest fire station.
   - When theft, loss, or some other accident occurs, report to the nearest police station.

In the case of an accident please take the above actions and inform Japan Radioisotope Association, Second Service Division, as soon as possible (Telephone : 03-5395-8031, Telephone on holidays and at night : 03-3946-6305).

CONTRIBUTORS TO DRAFTING AND REVIEW

Abouchaar, J.	International Air Transport Association
Agarwal, S.	Atomic Energy Regulatory Board, India
Ando, H.	Japan Nuclear Cycle Development Institute, Japan
Azurin, C.	Permanent Mission of Peru to IAEA, Vienna
Bakalova, A.	Nuclear Regulatory Agency, Bulgaria
Bekker, A.	NTP Radioisotopes (Pty) Ltd, South Africa
Brown, R.	Technology Commercialization International Inc., United States of America
Capadona, N.	Nuclear Regulatory Authority Office, Argentina
Charette, M.-A.	MDS Nordion, Canada
Christ, R.	World Nuclear Transport Institute, United Kingdom
Clark, R.W.	Transport Canada, Canada
Clement, C.	Canadian Nuclear Safety Commission, Canada
Desnoyers, B.	COGEMA Logistics, France
Eshraghi, A.	National Radiation Protection Department, Islamic Republic of Iran
Fasten, C.	Bundesamt für Strahlenschutz, Germany
Ferate, F.	US Department of Transportation, United States of America
Finne, I.E.	Norwegian Radiation Protection Authority, Norway
Gessl, M.	International Federation of Air Line Pilots' Associations
Hallemans, J.	European Commission

Ito, C.	Central Research Institute of Electric Power Industry, Japan
Jacob, E.	Direction générale de la sûreté nucléaire et de la radioprotection, France
Josefsson, D.	Swedish Radiation Protection Authority, Sweden
Kerekes, A.	National Research Institute for Radiobiology and Radiohygiene, Hungary
Koça, I.	Permanent Mission of Turkey to IAEA, Vienna
Lewis, R.	US Nuclear Regulatory Commission, United States of America
Liebens, M.	Regulatory and Licensing Department, Belgium
Lizot, M.	Institut de la radioprotection et de la sûreté nucléaire, France
Malesys, P.	International Organization for Standardization
Nelson, P.	Canadian Nuclear Safety Commission, Canada
Orsini, A.	ENEA, Italy
Perrin, M.-L.	Institut de la radioprotection et de la sûreté nucléaire, France
Pu, Y.	China National Nuclear Corporation, China
Rahman, F.M.A.	National Centre of Nuclear Safety and Radiation Control (NCNSRC), Egypt
Sáfár, J.	Hungarian Atomic Energy Authority, Hungary
Sannen, H.	Transnubel, Belgium
Schuurman, W.	International Federation of Air Line Pilots' Associations
Schwarz, G.	Gesellschaft für Reaktorsicherheit, Germany

Shaw, K.B.	Radiation Protection Division, Health Protection Agency, United Kingdom
Sonawane, A.U.	Atomic Energy Regulatory Board, India
Stewart, J.	Department of Transport, United Kingdom
Suzuki, H.	International Standards Group, Japan
Svahn, B.	Swedish Radiation Protection Institute, Sweden
Tétényi, P.	Institute of Isotope and Surface Chemistry, Hungary
Trivelloni, S.	Department for Nuclear and for Technological and Industrial Risk, Italy
Van Halem, H.	Directorate for Chemicals, Waste and Radiation Protection, Netherlands
Vieru, G.	Institute for Nuclear Research, Romania
Warden, D.	Amersham plc, United Kingdom
Wilkinson, W.	World Nuclear Trade Institute
Young, C.N.	Department of Transport, United Kingdom
Zainal Abidin, H.	Atomic Energy Licensing Board, Malaysia

BODIES FOR THE ENDORSEMENT OF IAEA SAFETY STANDARDS

An asterisk denotes a corresponding member. Corresponding members receive drafts for comment and other documentation but they do not generally participate in meetings.

Commission on Safety Standards

Argentina: Oliveira, A.; *Australia*: Loy, J.; *Brazil*: Souza de Assis, A.; *Canada*: Pereira, J.K.; *China*: Li, G.; *Czech Republic*: Drábová, D.; *Denmark*: Ulbak, K.; *Egypt*: Abdel-Hamid, S.B.; *France*: Lacoste, A.-C. (Chairperson); *Germany*: Majer, D.; *India*: Sharma, S.K.; *Israel*: Levanon, I.; *Japan*: Abe, K.; *Korea, Republic of*: Eun, Y.-S.; *Pakistan*: Hashmi, J.; *Russian Federation*: Malyshev, A.B.; *South Africa*: Magugumela, M.T.; *Spain*: Azuara, J.A.; *Sweden*: Holm, L.-E.; *Switzerland*: Schmocker, U.; *United Kingdom*: Weightman, M.; *United States of America*: Virgilio, M.; *European Commission*: Waeterloos, C.; *IAEA*: Karbassioun, A. (Coordinator); *International Commission on Radiological Protection*: Holm, L.-E.; *OECD Nuclear Energy Agency*: Tanaka, T.

Nuclear Safety Standards Committee

Argentina: Sajaroff, P.; *Australia*: MacNab, D.; *Austria*: Sholly, S.; *Belgium*: Govaerts, P.; *Brazil*: de Queiroz Bogado Leite, S.; **Bulgaria*: Gladychev, Y.; *Canada*: Newland, D.; *China*: Wang, J.; *Croatia*: Valčić, I.; **Cyprus*: Demetriades, P.; *Czech Republic*: Böhm, K.; *Egypt*: Aly, A.I.M.; *Finland*: Reiman, L. (Chairperson); *France*: Saint Raymond, P.; *Germany*: Herttrich, M.; **Greece*: Camarinopoulos, L.; *Hungary*: Vöröss, L.; *India*: Kushwaha, H.S.; *Iran, Islamic Republic of*: Alidousti, A.; **Iraq*: Khalil Al-Kamil, A.-M.; *Ireland*: Hone, C.; *Israel*: Hirshfeld, H.; *Italy*: Bava, G.; *Japan*: Nakamura, K.; *Korea, Republic of*: Kim, H.-K.; *Lithuania*: Demčenko, M.; *Mexico*: González Mercado, V.; *Netherlands*: Jansen, R.; *Pakistan*: Habib, M.A.; *Paraguay*: Troche Figueredo, G.D.; **Peru*: Ramírez Quijada, R.; *Portugal*: Marques, J.J.G.; *Romania*: Biro, L.; *Russian Federation*: Shvetsov, Y.E.; *Slovakia*: Uhrik, P.; *Slovenia*: Levstek, M.F.; *South Africa*: Bester, P.J.; *Spain*: Zarzuela, J.; *Sweden*: Hallman, A.; *Switzerland*: Aeberli, W.; **Thailand*: Tanipanichskul, P.; *Turkey*: Bezdegumeli, U.; *Ukraine*: Bezsalyi, V.; *United Kingdom*: Vaughan, G.J.; *United States of America*: Mayfield, M.E.; *European Commission*: Vigne, S.; *IAEA*: Feige, G. (Coordinator); *International Organization for Standardization*:

Nigon, J.L.; *OECD Nuclear Energy Agency*: Reig, J.; **World Nuclear Association*: Saint-Pierre, S.

Radiation Safety Standards Committee

Argentina: Rojkind, R.H.A.; *Australia*: Melbourne, A.; **Belarus*: Rydlevski, L.; *Belgium*: Smeesters, P.; *Brazil*: Rodriguez Rochedo, E.R.; **Bulgaria*: Katzarska, L.; *Canada*: Clement, C.; *China*: Yang, H.; *Costa Rica*: Pacheco Jimenez, R.; *Cuba*: Betancourt Hernandez, L.; **Cyprus*: Demetriades, P.; *Czech Republic*: Petrova, K.; *Denmark*: Ohlenschlager, M.; **Egypt*: Hassib, G.M; *Finland*: Markkanen, M.; *France*: Godet, J.; *Germany*: Landfermann, H.; **Greece*: Kamenopoulou, V.; *Hungary*: Koblinger, L.; *Iceland*: Magnusson, S. (Chairperson); *India*: Sharma, D.N.; *Indonesia*: Akhadi, M.; *Iran, Islamic Republic of*: Rastkhah, N.; **Iraq*: Khalil Al-Kamil, A.-M.; *Ireland*: Colgan, T.; *Israel*: Laichter, Y.; *Italy*: Bologna, L.; *Japan*: Yoda, N.; *Korea, Republic of*: Lee, B.; *Latvia*: Salmins, A.; *Malaysia*: Rehir, D.; *Mexico*: Maldonado Mercado, H.; *Morocco*: Tazi, S.; *Netherlands*: Zuur, C.; *Norway*: Saxebol, G.; *Pakistan*: Mehboob, A.E.; *Paraguay*: Idoyago Navarro, M.; *Philippines*: Valdezco, E.; *Portugal*: Dias de Oliviera, A.; *Romania*: Rodna, A.; *Russian Federation*: Savkin, M.; *Slovakia*: Jurina, V.; *Slovenia*: Sutej, T.; *South Africa*: Olivier, J.H.I.; *Spain*: Amor, I.; *Sweden*: Hofvander, P.; *Switzerland*: Pfeiffer, H.J.; **Thailand*: Wanitsuksombut, W.; *Turkey*: Okyar, H.; *Ukraine*: Holubiev, V.; *United Kingdom*: Robinson, I.; *United States of America*: Miller, C.; *European Commission*: Janssens, A.; *Food and Agriculture Organization of the United Nations*: Byron, D.; *IAEA*: Boal, T. (Coordinator); *International Commission on Radiological Protection*: Valentin, J.; *International Labour Office*: Niu, S.; *International Organization for Standardization*: Perrin, M.; *OECD Nuclear Energy Agency*: Lazo, T.; *Pan American Health Organization*: Jimenez, P.; *United Nations Scientific Committee on the Effects of Atomic Radiation*: Crick, M.; *World Health Organization*: Carr, Z.; *World Nuclear Association*: Saint-Pierre, S.

Transport Safety Standards Committee

Argentina: López Vietri, J.; *Australia*: Sarkar, S.; *Austria*: Kirchnawy, F.; *Belgium*: Cottens, E.; *Brazil*: Mezrahi, A.; *Bulgaria*: Bakalova, A.; *Canada*: Faille, S.; *China*: Qu, Z.; *Croatia*: Kubelka, D.; *Cuba*: Quevedo Garcia, J.R.; **Cyprus*: Demetriades, P.; *Czech Republic*: Ducháček, V.; *Denmark*: Breddan, K.; **Egypt*: El-Shinawy, R.M.K.; *Finland*: Tikkinen, J.; *France*: Aguilar, J.; *Germany*: Rein, H.; **Greece*: Vogiatzi, S.; *Hungary*: Sáfár, J.; *India*:

Agarwal, S.P.; *Iran, Islamic Republic of*: Kardan, M.R.; **Iraq*: Khalil Al-Kamil, A.-M.; *Ireland*: Duffy, J. (Chairperson); *Israel*: Koch, J.; *Italy*: Trivelloni, S.; *Japan*: Amano, M.; *Korea, Republic of*: Kim, Y.-J.; *Malaysia*: Sobari, M.P.M.; *Netherlands*: Van Halem, H.; *New Zealand*: Ardouin, C.; *Norway*: Hornkjøl, S.; *Pakistan*: Rashid, M.; *Paraguay*: More Torres, L.E.; *Philippines*: Kinilitan-Parami, V.; *Portugal*: Buxo da Trindade, R.; *Romania*: Vieru, G.; *Russian Federation*: Ershov, V.N.; *South Africa*: Jutle, K.; *Spain*: Zamora Martin, F.; *Sweden*: Dahlin, G.; *Switzerland*: Knecht, B.; **Thailand*: Wanitsuksombut, W.; *Turkey*: Ertürk, K.; *Ukraine*: Sakalo, V.; *United Kingdom*: Young, C.N.; *United States of America*: Brach, W.E.; Boyle, R.; *European Commission*: Venchiarutti, J.-C.; *International Air Transport Association*: Abouchaar, J.; *IAEA*: Wangler, M.E. (Coordinator); *International Civil Aviation Organization*: Rooney, K.; *International Federation of Air Line Pilots' Associations*: Tisdall, A.; *International Maritime Organization*: Rahim, I.; *International Organization for Standardization*: Malesys, P.; *United Nations Economic Commission for Europe*: Kervella, O.; *Universal Postal Union*: Giroux, P.; *World Nuclear Transport Institute*: Green, L.

Waste Safety Standards Committee

Argentina: Siraky, G.; *Australia*: Williams, G.; *Austria*: Hohenberg, J.; *Belgium*: Baekelandt, L.; *Brazil*: Heilbron, P.; **Bulgaria*: Simeonov, G.; *Canada*: Lojk, R.; *China*: Fan, Z.; *Croatia*: Subasic, D.; *Cuba*: Salgado Mojena, M.; **Cyprus*: Demetriades, P.; **Czech Republic*: Lieteva, P.; *Denmark*: Nielsen, C.; **Egypt*: El-Adham, K.E.A.; *Finland*: Ruokola, E.; *France*: Cailleton, R.; *Hungary*: Czoch, I.; *India*: Raj, K.; *Indonesia*: Yatim, S.; *Iran, Islamic Republic of*: Ettehadian, M.; **Iraq*: Abass, H.; *Israel*: Dody, A.; *Italy*: Dionisi, M.; *Japan*: Ito, Y.; *Korea, Republic of*: Park, W.; **Latvia*: Salmins, A.; *Lithuania*: Paulikas, V.; *Mexico*: Aguirre Gómez, J.; *Morocco*: Soufi, I.; *Netherlands*: Selling, H.; **Norway*: Sorlie, A.; *Pakistan*: Rehman, R.; *Paraguay*: Facetti Fernandez, J.; *Portugal*: Flausino de Paiva, M.; *Romania*: Tuturici, I.; *Russian Federation*: Poluektov, P.P.; *Slovakia*: Konečný, L.; *Slovenia*: Mele, I.; *South Africa*: Pather, T. (Chairperson); *Spain*: Sanz, M.; *Sweden*: Wingefors, S.; *Switzerland*: Zurkinden, A.; *Turkey*: Özdemir, T.; *Ukraine*: Ievlev, S.; *United Kingdom*: Wilson, C.; *United States of America*: Camper, L.; *European Commission*: Hilden, W.; *IAEA*: Hioki, K. (Coordinator); *International Organization for Standardization*: Hutson, G.; *OECD Nuclear Energy Agency*: Riotte, H.; *World Nuclear Association*: Saint-Pierre, S.

Safety through international standards

“The IAEA’s standards have become a key element of the global safety regime for the beneficial uses of nuclear and radiation related technologies.

“IAEA safety standards are being applied in nuclear power generation as well as in medicine, industry, agriculture, research and education to ensure the proper protection of people and the environment.”

Mohamed ElBaradei
IAEA Director General

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA
ISBN 92–0–109706–9
ISSN 1020–525X