

IAEA Safety Standards

for protecting people and the environment

Radiation Protection Programmes for the Transport of Radioactive Material

Specific Safety Guide

No. SSG-86



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International Atomic Energy Agency



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IAEA SAFETY STANDARDS

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The publications by means of which the IAEA establishes standards are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety. The publication categories in the series are **Safety Fundamentals**, **Safety Requirements** and **Safety Guides**.

Information on the IAEA's safety standards programme is available on the IAEA Internet site

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The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at: Vienna International Centre, PO Box 100, 1400 Vienna, Austria.

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Security related publications are issued in the **IAEA Nuclear Security Series**.

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RADIATION PROTECTION
PROGRAMMES FOR
THE TRANSPORT OF
RADIOACTIVE MATERIAL



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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. SSG-86

RADIATION PROTECTION PROGRAMMES FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
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FOREWORD

by Rafael Mariano Grossi
Director General

The IAEA's Statute authorizes it to "establish...standards of safety for protection of health and minimization of danger to life and property". These are standards that the IAEA must apply to its own operations, and that States can apply through their national regulations.

The IAEA started its safety standards programme in 1958 and there have been many developments since. As Director General, I am committed to ensuring that the IAEA maintains and improves upon this integrated, comprehensive and consistent set of up to date, user friendly and fit for purpose safety standards of high quality. Their proper application in the use of nuclear science and technology should offer a high level of protection for people and the environment across the world and provide the confidence necessary to allow for the ongoing use of nuclear technology for the benefit of all.

Safety is a national responsibility underpinned by a number of international conventions. The IAEA safety standards form a basis for these legal instruments and serve as a global reference to help parties meet their obligations. While safety standards are not legally binding on Member States, they are widely applied. They have become an indispensable reference point and a common denominator for the vast majority of Member States that have adopted these standards for use in national regulations to enhance safety in nuclear power generation, research reactors and fuel cycle facilities as well as in nuclear applications in medicine, industry, agriculture and research.

The IAEA safety standards are based on the practical experience of its Member States and produced through international consensus. The involvement of the members of the Safety Standards Committees, the Nuclear Security Guidance Committee and the Commission on Safety Standards is particularly important, and I am grateful to all those who contribute their knowledge and expertise to this endeavour.

The IAEA also uses these safety standards when it assists Member States through its review missions and advisory services. This helps Member States in the application of the standards and enables valuable experience and insight to be shared. Feedback from these missions and services, and lessons identified from events and experience in the use and application of the safety standards, are taken into account during their periodic revision.

I believe the IAEA safety standards and their application make an invaluable contribution to ensuring a high level of safety in the use of nuclear technology. I encourage all Member States to promote and apply these standards, and to work with the IAEA to uphold their quality now and in the future.

THE IAEA SAFETY STANDARDS

BACKGROUND

Radioactivity is a natural phenomenon and natural sources of radiation are features of the environment. Radiation and radioactive substances have many beneficial applications, ranging from power generation to uses in medicine, industry and agriculture. The radiation risks to workers and the public and to the environment that may arise from these applications have to be assessed and, if necessary, controlled.

Activities such as the medical uses of radiation, the operation of nuclear installations, the production, transport and use of radioactive material, and the management of radioactive waste must therefore be subject to standards of safety.

Regulating safety is a national responsibility. However, radiation risks may transcend national borders, and international cooperation serves to promote and enhance safety globally by exchanging experience and by improving capabilities to control hazards, to prevent accidents, to respond to emergencies and to mitigate any harmful consequences.

States have an obligation of diligence and duty of care, and are expected to fulfil their national and international undertakings and obligations.

International safety standards provide support for States in meeting their obligations under general principles of international law, such as those relating to environmental protection. International safety standards also promote and assure confidence in safety and facilitate international commerce and trade.

A global nuclear safety regime is in place and is being continuously improved. IAEA safety standards, which support the implementation of binding international instruments and national safety infrastructures, are a cornerstone of this global regime. The IAEA safety standards constitute a useful tool for contracting parties to assess their performance under these international conventions.

THE IAEA SAFETY STANDARDS

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property, and to provide for their application.

With a view to ensuring the protection of people and the environment from harmful effects of ionizing radiation, the IAEA safety standards establish fundamental safety principles, requirements and measures to control the radiation exposure of people and the release of radioactive material to the environment, to restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation, and to mitigate the consequences of such events if they were to occur. The standards apply to facilities and activities that give rise to radiation risks, including nuclear installations, the use of radiation and radioactive sources, the transport of radioactive material and the management of radioactive waste.

Safety measures and security measures¹ have in common the aim of protecting human life and health and the environment. Safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

The IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation. They are issued in the IAEA Safety Standards Series, which has three categories (see Fig. 1).

Safety Fundamentals

Safety Fundamentals present the fundamental safety objective and principles of protection and safety, and provide the basis for the safety requirements.

Safety Requirements

An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered ‘overarching’ requirements, are expressed as ‘shall’ statements. Many requirements are not addressed to a specific party, the implication being that the appropriate parties are responsible for fulfilling them.

Safety Guides

Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it

¹ See also publications issued in the IAEA Nuclear Security Series.

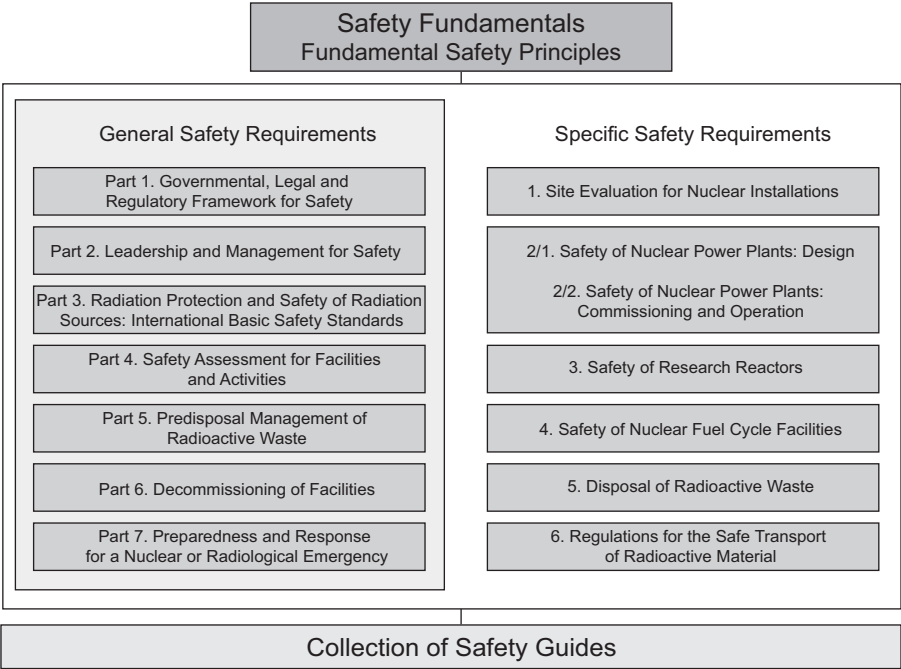


FIG. 1. The long term structure of the IAEA Safety Standards Series.

is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as ‘should’ statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

The principal users of safety standards in IAEA Member States are regulatory bodies and other relevant national authorities. The IAEA safety standards are also used by co-sponsoring organizations and by many organizations that design, construct and operate nuclear facilities, as well as organizations involved in the use of radiation and radioactive sources.

The IAEA safety standards are applicable, as relevant, throughout the entire lifetime of all facilities and activities — existing and new — utilized for peaceful purposes and to protective actions to reduce existing radiation risks. They can be

used by States as a reference for their national regulations in respect of facilities and activities.

The IAEA's Statute makes the safety standards binding on the IAEA in relation to its own operations and also on States in relation to IAEA assisted operations.

The IAEA safety standards also form the basis for the IAEA's safety review services, and they are used by the IAEA in support of competence building, including the development of educational curricula and training courses.

International conventions contain requirements similar to those in the IAEA safety standards and make them binding on contracting parties. The IAEA safety standards, supplemented by international conventions, industry standards and detailed national requirements, establish a consistent basis for protecting people and the environment. There will also be some special aspects of safety that need to be assessed at the national level. For example, many of the IAEA safety standards, in particular those addressing aspects of safety in planning or design, are intended to apply primarily to new facilities and activities. The requirements established in the IAEA safety standards might not be fully met at some existing facilities that were built to earlier standards. The way in which IAEA safety standards are to be applied to such facilities is a decision for individual States.

The scientific considerations underlying the IAEA safety standards provide an objective basis for decisions concerning safety; however, decision makers must also make informed judgements and must determine how best to balance the benefits of an action or an activity against the associated radiation risks and any other detrimental impacts to which it gives rise.

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

The preparation and review of the safety standards involves the IAEA Secretariat and five Safety Standards Committees, for emergency preparedness and response (EPReSC) (as of 2016), nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC), and a Commission on Safety Standards (CSS) which oversees the IAEA safety standards programme (see Fig. 2).

All IAEA Member States may nominate experts for the Safety Standards Committees and may provide comments on draft standards. The membership of the Commission on Safety Standards is appointed by the Director General and includes senior governmental officials having responsibility for establishing national standards.

A management system has been established for the processes of planning, developing, reviewing, revising and establishing the IAEA safety standards.

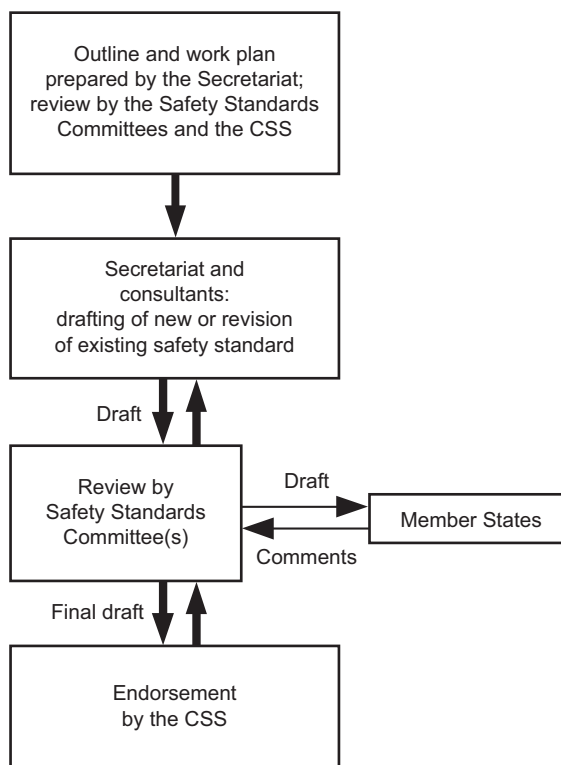


FIG. 2. The process for developing a new safety standard or revising an existing standard.

It articulates the mandate of the IAEA, the vision for the future application of the safety standards, policies and strategies, and corresponding functions and responsibilities.

INTERACTION WITH OTHER INTERNATIONAL ORGANIZATIONS

The findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the recommendations of international expert bodies, notably the International Commission on Radiological Protection (ICRP), are taken into account in developing the IAEA safety standards. Some safety standards are developed in cooperation with other bodies in the United Nations system or other specialized agencies, including the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization and the World Health Organization.

INTERPRETATION OF THE TEXT

Safety related terms are to be understood as defined in the IAEA Nuclear Safety and Security Glossary (see <https://www.iaea.org/resources/publications/iaea-nuclear-safety-and-security-glossary>). Otherwise, words are used with the spellings and meanings assigned to them in the latest edition of The Concise Oxford Dictionary. For Safety Guides, the English version of the text is the authoritative version.

The background and context of each standard in the IAEA Safety Standards Series and its objective, scope and structure are explained in Section 1, Introduction, of each publication.

Material for which there is no appropriate place in the body text (e.g. material that is subsidiary to or separate from the body text, is included in support of statements in the body text, or describes methods of calculation, procedures or limits and conditions) may be presented in appendices or annexes.

An appendix, if included, is considered to form an integral part of the safety standard. Material in an appendix has the same status as the body text, and the IAEA assumes authorship of it. Annexes and footnotes to the main text, if included, are used to provide practical examples or additional information or explanation. Annexes and footnotes are not integral parts of the main text. Annex material published by the IAEA is not necessarily issued under its authorship; material under other authorship may be presented in annexes to the safety standards. Extraneous material presented in annexes is excerpted and adapted as necessary to be generally useful.

CONTENTS

1.	INTRODUCTION.....	1
	Background (1.1–1.3).....	1
	Objective (1.4)	2
	Scope (1.5)	2
	Structure (1.6, 1.7)	2
2.	RADIATION PROTECTION PROGRAMMES FOR THE TRANSPORT OF RADIOACTIVE MATERIAL	3
	Objectives of radiation protection programmes for the transport of radioactive material (2.1–2.6)	3
	Overview of elements of a radiation protection programme for the transport of radioactive material (2.7)	4
	Application of a graded approach to radiation protection programmes for the transport of radioactive material (2.8–2.11) ...	5
3.	THE SCOPE OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL (3.1–3.6)	6
4.	ASSIGNMENT OF ROLES AND RESPONSIBILITIES FOR A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL (4.1).....	7
	Responsibilities of transport organizations in relation to radiation protection programmes (4.2–4.12)	7
	Responsibilities of the competent authority in relation to radiation protection programmes (4.13–4.15)	10
5.	DOSE ASSESSMENT AND OPTIMIZATION OF PROTECTION FOR THE TRANSPORT OF RADIOACTIVE MATERIAL.....	11
	Prior radiological evaluation for the transport of radioactive material (5.1–5.3)	11
	Radiation monitoring in the transport of radioactive material (5.4–5.17)	12

Methods for estimating external exposures from the transport of radioactive material (5.18–5.26)	16
Dose limits and the optimization of protection in the transport of radioactive material (5.27–5.33)	20
6. SURFACE CONTAMINATION CONSIDERATIONS IN THE RADIATION PROTECTION PROGRAMME FOR TRANSPORT (6.1–6.7)	22
7. SEGREGATION AND OTHER PROTECTIVE MEASURES IN THE RADIATION PROTECTION PROGRAMME FOR TRANSPORT (7.1)	24
Segregation measures in the radiation protection programme for transport (7.2–7.6)	24
Restriction of exposure times in the radiation protection programme for transport (7.7)	25
Use of shielding in the radiation protection programme for transport (7.8, 7.9)	26
Controlled and supervised areas in the radiation protection programme for transport (7.10–7.13)	26
8. EMERGENCY PREPAREDNESS AND RESPONSE AS PART OF THE RADIATION PROTECTION PROGRAMME FOR TRANSPORT (8.1–8.6)	27
Emergency preparedness as part of the radiation protection programme for transport (8.7–8.9)	29
Emergency response as part of the radiation protection programme for transport (8.10, 8.11)	30
Protection of emergency workers and helpers as part of the radiation protection programme for transport (8.12)	30
9. TRAINING AS PART OF THE RADIATION PROTECTION PROGRAMME FOR TRANSPORT (9.1–9.9)	31
10. MANAGEMENT SYSTEM FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL (10.1, 10.2)	33
REFERENCES	35

ANNEX I:	GENERIC EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL.....	39
ANNEX II:	EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF MEDICAL RADIOISOTOPES.....	49
ANNEX III:	EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR AN AIR CARGO CARRIER....	54
ANNEX IV:	EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL BY AN INDUSTRIAL RADIOGRAPHY COMPANY.....	61
ANNEX V:	EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL FOR OPERATORS OF PORTS.....	66
ANNEX VI:	EXAMPLE OF A RADIATION PROTECTION PROGRAMME FOR A VESSEL.....	69
ANNEX VII:	QUESTIONNAIRE FOR EVALUATING THE EFFECTIVENESS OF RADIATION PROTECTION PROGRAMMES.....	74
ANNEX VIII:	REQUIREMENTS OF THE INTERNATIONAL MARITIME DANGEROUS GOODS CODE FOR SEGREGATION OF PACKAGES CONTAINING RADIOACTIVE MATERIAL.....	76
CONTRIBUTORS TO DRAFTING AND REVIEW.....		79

1. INTRODUCTION

BACKGROUND

1.1. IAEA Safety Standards Series No. SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material, 2018 Edition [1] (hereinafter referred to as ‘the Transport Regulations’) provides a regulatory framework for the safe transport of all types of radioactive material, such as naturally occurring radioactive material; radioactive sources used in academic, industrial and medical applications; nuclear fuel; and radioactive waste. The Transport Regulations cover all facets of safe transport by means of a set of technical and administrative safety requirements, including for the actions of transport organizations¹ and competent authorities.

1.2. The fundamental requirements for radiation protection are stated in para. 301 of the Transport Regulations. Paragraph 302 of the Transport Regulations states:

“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 exposure.”

Paragraph 234 of the Transport Regulations defines a radiation protection programme (RPP) as “systematic arrangements that are aimed at providing adequate consideration of radiation protection measures.”

1.3. IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [2], establishes radiation protection requirements for planned exposure situations, including the transport of radioactive material. Recommendations on meeting the requirements of GSR Part 3 [2] for occupational radiation protection, including the development of an RPP, are provided in IAEA Safety Standards Series No. GSG-7, Occupational Radiation Protection [3]. Recommendations on meeting the requirements of GSR Part 3 [2] for public exposures are provided in IAEA Safety Standards Series No. GSG-8, Radiation Protection of the Public and the Environment [4].

¹ In this Safety Guide, a ‘transport organization’ is a person or an organization associated with, and involved in, the transport of radioactive material that prepares, consigns, loads, carries (including storage in transit), ships after storage, unloads, receives or otherwise uses a package in connection with the transport of radioactive material.

OBJECTIVE

1.4. This Safety Guide provides recommendations on meeting the requirements established in para. 302 of the Transport Regulations for an RPP for the transport of radioactive material. The intended audience for the Safety Guide includes competent authorities, consignors, carriers, consignees and operators of ports (e.g. harbours, seaports, airports). This Safety Guide will also be of interest to the employees of public authorities (e.g. custom authorities, harbour authorities, port authorities, modal authorities) concerning activities associated with the transport of radioactive material that involve radiation exposure.

SCOPE

1.5. The scope of this Safety Guide is the same as in para. 106 of the Transport Regulations: the transport of radioactive material by all modes on land, on water or in the air, including transport that is incidental to the use of the radioactive material.

STRUCTURE

1.6. This Safety Guide consists of ten sections. Section 2 discusses the objectives and the application of a graded approach to RPPs. Section 3 discusses the scope and provides an overview of the basic elements of an RPP. Sections 4–10 provide recommendations on the elements of an RPP, namely the associated roles and responsibilities, dose assessment and optimization, control of surface contamination, segregation and other protective measures, emergency preparedness and response, training, and the management system.

1.7. Eight annexes are included in this Safety Guide. They include examples to support the development of RPPs, questions that can be used for evaluating the effectiveness of RPPs and an excerpt from the International Maritime Dangerous Goods (IMDG) Code [5] on segregation distances.

2. RADIATION PROTECTION PROGRAMMES FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

OBJECTIVES OF RADIATION PROTECTION PROGRAMMES FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

2.1. Paragraph 3.49 of GSG-7 [3] states:

“The general objective of the radiation protection programme is to fulfil the management’s responsibility for protection and safety through the adoption of management structures, policies, procedures and organizational arrangements that are commensurate with the nature and extent of the risks. The radiation protection programme should cover all the main elements contributing to protection and safety.”

2.2. Paragraph 302.1 of IAEA Safety Standards Series No. SSG-26 (Rev. 1), Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2018 Edition) [6], states:

“The objectives of the RPP for the transport of radioactive material are:

- (a) To provide for adequate consideration of radiation protection measures in transport;
- (b) To ensure that the system of radiation protection is adequately applied;
- (c) To enhance a safety culture in the transport of radioactive material;
- (d) To provide practical measures to meet these objectives.”

The primary aim of an RPP should be to optimize radiation protection in the transport of radioactive material [2, 3].

2.3. An RPP is required by para. 302 of the Transport Regulations to incorporate the requirements of paras 301, 303–305, 311 and 562 of the Transport Regulations. Relevant national requirements should also be incorporated into the RPP.

2.4. The RPP may be documented in one or more documents (and may be either a separate programme or part of a facility’s RPP; see para. 3.6) and should be included in the management system of the transport organization (see Section 10).

2.5. General requirements on leadership and management for safety, including establishing, sustaining and continually improving an effective management

system, are established in IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [7]. Guidance on management systems for the safe transport of radioactive material is given in IAEA Safety Standards Series No. TS-G-1.4, The Management System for the Safe Transport of Radioactive Material [8].

2.6. An RPP does not usually address arrangements for criticality safety. Recommendations on such arrangements are provided in SSG-26 (Rev. 1) [6] and IAEA Safety Standards Series No. SSG-27 (Rev. 1), Criticality Safety in the Handling of Fissile Material [9].

OVERVIEW OF ELEMENTS OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

2.7. Paragraph 302.2 of SSG-26 (Rev. 1) [6] states:

“The RPP should include, to the extent appropriate, the following elements:

- (a) Scope of the programme (see paras 302.3–302.5 [of SSG-26 (Rev. 1) [6]]);
- (b) Roles and responsibilities for the implementation of the programme (see para. 302.6 [of SSG-26 (Rev. 1) [6]]);
- (c) Dose assessment and optimization (see para. 303 of the Transport Regulations);
- (d) Assessment of surface contamination (see paras 508, 513 and 514 of the Transport Regulations);
- (e) Segregation and other protective measures (see paras 562.1–562.13 [of SSG-26 (Rev. 1) [6]]);
- (f) Emergency response arrangements (see paras 304 and 305 of the Transport Regulations);
- (g) Training (see paras 311–315 of the Transport Regulations);
- (h) Management system (see para. 306 of the Transport Regulations).”

APPLICATION OF A GRADED APPROACH TO RADIATION PROTECTION PROGRAMMES FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

2.8. The radiation protection provisions incorporated into an RPP may be diverse and may reflect, for example, regulatory requirements and managerial and operational criteria for radiation protection in the transport of radioactive material. Paragraph 302 of the Transport Regulations states that “The nature and extent of the measures to be employed in the programme shall be related to the magnitude and likelihood of radiation exposure.”

2.9. Paragraph 303 of the Transport Regulations establishes a graded approach to the assessment of occupational exposures, as follows:

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

- (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; or
- (b) Is likely to exceed 6 mSv in a year, individual monitoring shall be conducted.”

In situations in which occupational exposures from transport activities are likely to be less than 1 mSv in a year, initial confirmatory monitoring and repeat confirmatory monitoring at suitable periods should be considered.

2.10. Transport operations involving only a small number of shipments of packages of lower potential radiological hazard should have at least a basic programme for the assessment of occupational exposures, while more significant operations (e.g. transport operations involving diverse types of radioactive material and transport operations with the potential for significant exposures) should have a more comprehensive programme.

2.11. Transport operations that result in low occupational exposures or those organizations that only occasionally transport radioactive material still require an RPP, in accordance with para. 302 of the Transport Regulations.

3. THE SCOPE OF A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

3.1. An RPP should cover all aspects of transport described in para. 106 of the Transport Regulations, and the associated conditions, including:

- (a) Routine conditions of transport (incident free);
- (b) Normal conditions of transport (minor mishaps);
- (c) Accident conditions of transport.

3.2. The RPP should include the measures needed to meet the requirements of the Transport Regulations for radiation protection, including monitoring provisions. Requirement 24 of GSR Part 3 [2] requires the establishment of an RPP for occupational exposure. However, as stated in para. 3.52 of GSG-7 [3], “the radiation protection programme could include protection of both workers and the public”. Consistent with para. 302 of the Transport Regulations, which requires that RPPs incorporate the requirements for, inter alia, limitation and optimization of doses to persons (para. 301 of the Transport Regulations), emergency response (paras 304 and 305 of the Transport Regulations) and segregation (para. 562 of the Transport Regulations), all of which may involve public exposure, the RPP for the transport of radioactive material should include the protection of both workers and the public.

3.3. The focus of an RPP for the transport of radioactive material should generally be on transport and handling operations that have the potential to result in radiation exposures or contamination of people, property or the environment. Such operations include the packing, preparation, loading, handling, storage in transit, carriage, intermodal transfer, delivery and unloading of packages of radioactive material, as well as the inspection and maintenance of packaging (if contaminated or containing residual radioactive material).

3.4. An RPP should define and document a systematic framework of controls to be applied by a transport organization, with the primary aim of optimizing radiation protection in the transport of radioactive material. The RPP should be developed and implemented during the pre-operational stage of the shipment of radioactive material, for example for such transport operations as the selection of an appropriate package type and the scheduling and preparation of packages containing radioactive material. Even if radiation protection has been optimized

at the pre-operational stage, there will still be a need for radiation protection arrangements and their optimization at the various stages of transport operations.

3.5. Transport related operations that do not involve occupational exposure or public exposure (e.g. administrative work; design and manufacture of packaging; repair of packaging that does not involve any radiation exposure) do not need to be covered by an RPP for transport.

3.6. Transport operations such as the packing, preparation, loading, handling, delivery and unloading of packages containing radioactive material often occur at facilities that are subject to regulatory requirements, for example nuclear power plants, nuclear fuel cycle facilities (including uranium mining and processing facilities), isotope production facilities, nuclear medicine departments in hospitals, and industrial facilities that use radioactive sources. Such facilities are required to have their own RPP that applies to their operations (see Requirement 24 of GSR Part 3 [2]), including the on-site movement of radioactive material. Transport operations associated with these facilities are often within the scope of the facility RPP, and in these cases the facility RPP should have provisions that address the transport activities that take place at the facility; however, in some cases, such transport operations may be covered by a transport specific RPP. See also paras 4.2–4.5.

4. ASSIGNMENT OF ROLES AND RESPONSIBILITIES FOR A RADIATION PROTECTION PROGRAMME FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

4.1. The Transport Regulations assign specific roles and responsibilities to transport organizations and competent authorities. This section provides recommendations on these duties and responsibilities in relation to the establishment and implementation of an RPP for the transport of radioactive material.

RESPONSIBILITIES OF TRANSPORT ORGANIZATIONS IN RELATION TO RADIATION PROTECTION PROGRAMMES

4.2. Requirement 4 of GSR Part 3 [2] states that **“The person or organization responsible for facilities and activities that give rise to radiation risks shall**

have the prime responsibility for protection and safety.” Therefore, the activities of each transport organization involved with a shipment of radioactive material (e.g. consignors; carriers; operators of harbours, seaports and airports; consignees) are required to be covered by an RPP. These activities should be specified under the scope of the RPP of the organization. It is the responsibility of the management of transport organizations directly involved in the radioactive material transport chain to establish and implement an RPP for their operations. It is unreasonable to assign the duty of establishing an additional RPP to a transport organization (e.g. the consignor) for a transport activity it has no direct control over (i.e. no staff are involved) and for which radiation protection provisions are applied by subsequent transport organizations (e.g. carriers).

4.3. Transport organizations should cooperate to fulfil the objectives of their RPPs. In more complex transport operations (e.g. a transboundary shipment of radioactive material by road, rail, air and sea), this may involve many independent carriers, where each party operates under its own management system (see Section 10), or several transport organizations that perform operations at the same site (e.g. port, airport) involving the same individuals, leading to an accumulation of doses to those individuals.

4.4. The RPP should address interfaces among the different transport organizations. A dedicated carrier may be contracted solely for transport operations by a consignor or consignee, and in such cases the consignor or consignee may have an RPP that covers the carrier’s operations. In such circumstances, the competent authority might not require the carrier to have a separate RPP solely for transport if the relevant consignor or consignee ensures that the radiation protection measures to be followed by the carrier are included in the consignor’s or consignee’s RPP. In the case of shipment under exclusive use of a conveyance or a large freight container (para. 221 of the Transport Regulations), the consignor or consignee, as appropriate, is responsible for ensuring that directions for loading, unloading and shipment are included in the RPP.

4.5. In some cases, a transport organization may prepare shipments at a facility operated by another organization. The transport organization should normally have its own RPP (i.e. for transport), and the facility should also have its own RPP (i.e. for activities it conducts within the facility). The scope of the two RPPs and the interfaces between them should be determined in advance and should be recorded.

4.6. The competent authority may require the consignor, carrier or consignee to evaluate the adequacy of the RPPs of its subcontractors involved in the transport of its consignments of radioactive material. Consignors or other individuals and

organizations with relevant experience and expertise, such as transport companies specialized in the organization of shipments of radioactive material, may also assist subcontractors in the development of their own RPPs.

4.7. The management of transport organizations are required to establish safety policies, management systems and organizational arrangements, and provide sufficient resources, to ensure that the objectives of the RPP can be achieved (see Requirements 3 and 6–9 of GSR Part 2 [7]). The management of each transport organization should also identify and document the objectives of the RPP.

4.8. The management system is required to reflect the management’s commitment to radiation protection by means of written policy statements (see para. 4.16 of GSR Part 2 [7]) and by clear support for those with responsibility for radiation protection (see para. 3.3 of GSR Part 2 [7]). The organizational arrangements include specifying and documenting the roles and responsibilities of the individuals involved and the functions to be performed by them (see para. 4.16 of GSR Part 2 [7]).

4.9. Infrastructure, arrangements and resources that may be necessary to achieve the objectives of the RPP include facilities, suitably qualified personnel, equipment, training, feedback mechanisms and the delegation of authority to individuals to perform actions to ensure compliance with regulatory requirements and with managerial and operational procedures. The individuals responsible for managing the RPP and the measures specified in it should be clearly designated and should be given the necessary authority to implement the programme and those measures.

4.10. With regard to the RPP, para. 302 of the Transport Regulations states that “Programme documents shall be available, on request, for inspection by the relevant *competent authority*.”

4.11. Requirement 22 of GSR Part 3 [2] states that “**Workers shall fulfil their obligations and carry out their duties for protection and safety.**” This requirement reflects the fact that workers contribute, by their own actions, to protection for themselves and others at work [3]. In addition, para. 3.83(a) of GSR Part 3 [2] states that workers “Shall follow any applicable rules and procedures for protection and safety as specified by the employer, registrant or licensee”.

4.12. Some tasks associated with the development or implementation of an RPP may be performed by a qualified expert² with relevant expertise (e.g. radiation protection, quality management). However, the overall responsibility for ensuring radiation protection and for compliance with regulatory requirements remains with the management of the transport organization.

RESPONSIBILITIES OF THE COMPETENT AUTHORITY IN RELATION TO RADIATION PROTECTION PROGRAMMES

4.13. Paragraph 307 of the Transport Regulations states that “The *competent authority* shall assure compliance with these Regulations.” To assure compliance with the requirements for an RPP in para. 302 of the Transport Regulations, various activities should be implemented by the competent authority, for example establishment of regulations and guidance concerning RPPs; inspections of management systems and transport operations; the implementation of enforcement actions, where appropriate; participation in training (i.e. providing training material, holding training courses and making personnel from the competent authority available to provide presentations at training courses); and distribution of information.

4.14. Recommendations on the development and maintenance of compliance assurance programmes are provided in IAEA Safety Standards Series No. SSG-78, Compliance Assurance for the Safe Transport of Radioactive Material [10]. Furthermore, guidance, procedures and checklists that may be used by a competent authority in relation to inspections of management systems, consignors, carriers and maintenance operations, including RPPs, are provided in annexes III–VII and IX to SSG-78 [10]. This information can be adapted and applied to other organizations involved in the transport of radioactive material.

4.15. Paragraph 308 of the Transport Regulations states that “The relevant *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 GSR Part 3 [2].” Examples of such an assessment are presented in Ref. [11] (for transport by road and rail), Ref. [12] (for transport by sea) and Ref. [13] (for transport by air).

² A qualified expert is an individual who, by virtue of certification by appropriate boards or societies, professional licence, or academic qualifications and experience, is duly recognized as having expertise in a relevant field of specialization (e.g. medical physics, radiation protection, occupational health, fire safety, quality management, any relevant engineering or safety specialty) [2].

5. DOSE ASSESSMENT AND OPTIMIZATION OF PROTECTION FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

PRIOR RADIOLOGICAL EVALUATION FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

5.1. A first step in establishing an RPP is the conduct of a prior radiological evaluation of the transport operations to be performed. Paragraph 3.55 of GSG-7 [3] states:

“The prior radiological evaluation should identify the following for all aspects of operations:

- (a) The sources of routine exposure and reasonably foreseeable potential exposure, such as surface contamination, airborne contamination and sources of external radiation.
- (b) The nature and magnitude of exposures in normal operations.
- (c) The nature, likelihood and magnitude of potential exposures....
- (d) The measures for protection and safety that are necessary to implement the optimization process.
- (e) Appropriate monitoring systems”.

5.2. Paragraph 3.56 of GSG-7 [3] states:

“The assessment of exposures in the prior radiological evaluation may be made by one or more of the following methods:

- (a) Use of workplace monitoring. This method can give a good assessment of the doses that workers will receive, provided that the radiological conditions in the workplace are reasonably predictable over a long period (at least for several months). Workplace monitoring should be repeated at appropriate intervals, and certainly when the working conditions change significantly.
- (b) Use of data from the scientific literature and information from comparable facilities. Some dose values are given in the literature for various workplace situations. These can, in principle, be used to judge whether monitoring is needed.

- (c) Use of simulations. Numerical simulations can be powerful and can provide information instantly on the parameters that influence doses that would be received in given exposure situations. The results of simulations should be verified by measurement.
- (d) Use of confirmatory measurements. Performing confirmatory measurements with personal dosimeters can help to determine whether individual monitoring is needed.”

5.3. With regard to transport operations, the prior radiological evaluation should take into account the following information:

- (a) The radionuclides, the activity levels, the physical and chemical form of radioactive material, the package type and category being transported, and the dose rates around packages and in and around vehicles.
- (b) The magnitude and likelihood of occupational exposures and public exposures arising from routine (incident free), normal (minor mishaps) and accident conditions of transport, taking into account the following: use of overpacks or freight containers; ad hoc stops, parking and delays due to traffic conditions during land transport; the necessity of storage in transit; the use of different modes of transport or conveyances and stowage within the conveyance; and specific handling procedures (e.g. for small packages or packages that are handled remotely). If applicable, this may also include consideration of potential exposures arising from failures to correctly assemble and use packages.
- (c) The number of workers involved and their activities that might involve exposure to radiation.
- (d) The duration and frequency of operations.
- (e) The distance between workers and packaged or unpackaged radioactive material.
- (f) The distance between members of the public and packaged or unpackaged radioactive material.
- (g) Shielding and other protective measures implemented to optimize radiation protection.

RADIATION MONITORING IN THE TRANSPORT OF RADIOACTIVE MATERIAL

5.4. A programme of radiation monitoring will be a fundamental part of any RPP. Paragraph 3.98 of GSG-7 [3] states:

“A programme of monitoring may serve various purposes, depending on the nature and extent of the practice. These purposes can include the following:

- (a) Assessing the exposure of workers and demonstrating compliance with regulatory requirements.
- (b) Confirming the effectiveness of working practices (e.g. the adequacy of supervision and training) and engineering standards.
- (c) Determining the radiological conditions in the workplace, whether these are under adequate control and whether operational changes have improved or worsened the situation.
- (d) Evaluating and improving operating procedures from a review of the collected monitoring data for individuals and groups. Such data may be used to identify both good and bad features of operating procedures and design characteristics, and thereby contribute to the development of safer working practices in relation to radiation.
- (e) Providing information that can be used to enable workers to understand how, when and where they are exposed, and to motivate them to take steps to reduce their exposure.
- (f) Providing information for the evaluation of doses in the event of accidental exposures.”

5.5. All transport organizations, including consignors, carriers and consignees, have some responsibilities for workplace, package and individual monitoring, depending on the radiological characteristics of the transport operations they undertake.

Workplace monitoring and package monitoring

5.6. Workplace monitoring comprises measurements made in the working environment as appropriate to the transport organization and the interpretation of such measurements. Routine monitoring in the workplace may be performed both to demonstrate that the work conditions remain satisfactory and to meet regulatory requirements. Additionally, the results of the monitoring may be used to assess the radiation exposures to workers. The measurements can be made anywhere transport operations are undertaken, such as areas (including conveyances) in which the packing, preparation, loading, handling, carriage, storage in transit, intermodal transfer, delivery, unloading and inspection of packages of radioactive material, and the maintenance of packaging for radioactive material, are performed. Such measurements comprise monitoring for external radiation, for surface contamination and in rare cases (e.g. the loading of drums with uranium oxide concentrate) for air contamination.