

IAEA Safety Standards

for protecting people and the environment

Radiation Safety in the Use of Radiation Sources in Research and Education

Specific Safety Guide

No. SSG-87



IAEA

International Atomic Energy Agency



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IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish or adopt standards of safety for protection of health and minimization of danger to life and property, and to provide for the application of these standards.

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

<https://www.iaea.org/resources/safety-standards>

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.

All users of IAEA safety standards are invited to inform the IAEA of experience in their use (e.g. as a basis for national regulations, for safety reviews and for training courses) for the purpose of ensuring that they continue to meet users' needs. Information may be provided via the IAEA Internet site or by post, as above, or by email to Official.Mail@iaea.org.

RELATED PUBLICATIONS

The IAEA provides for the application of the standards and, under the terms of Articles III and VIII.C of its Statute, makes available and fosters the exchange of information relating to peaceful nuclear activities and serves as an intermediary among its Member States for this purpose.

Reports on safety in nuclear activities are issued as **Safety Reports**, which provide practical examples and detailed methods that can be used in support of the safety standards.

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

The **IAEA Nuclear Energy Series** comprises informational publications to encourage and assist research on, and the development and practical application of, nuclear energy for peaceful purposes. It includes reports and guides on the status of and advances in technology, and on experience, good practices and practical examples in the areas of nuclear power, the nuclear fuel cycle, radioactive waste management and decommissioning.

RADIATION SAFETY
IN THE USE OF
RADIATION SOURCES IN
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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-87

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RESEARCH AND EDUCATION**

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2024

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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.

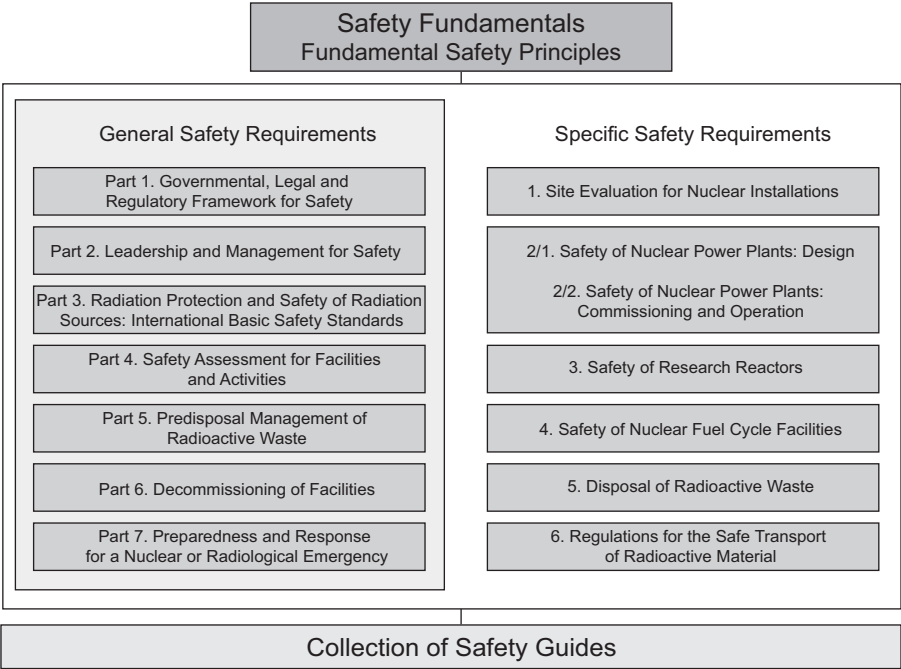


FIG. 1. The long term structure of the IAEA Safety Standards Series.

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.

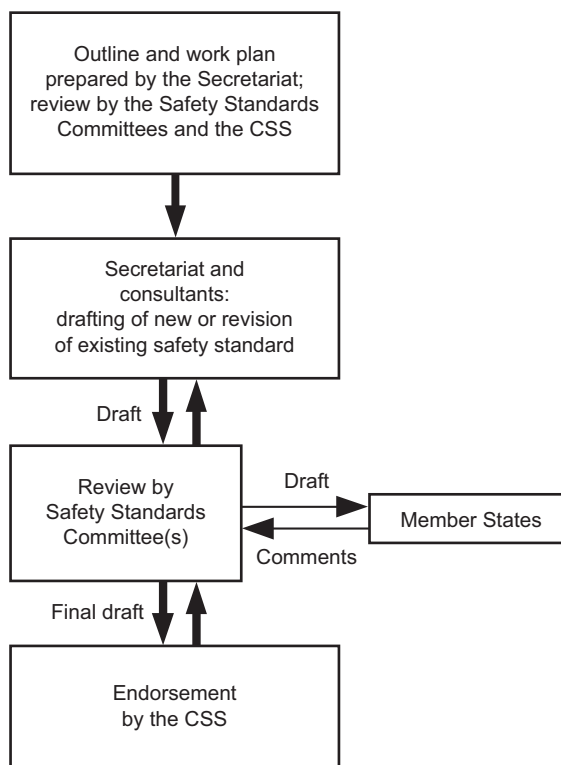


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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 (1.1–1.7).....	1
	Objective (1.8, 1.9).....	2
	Scope (1.10–1.14).....	3
	Structure (1.15, 1.16).....	3
2.	RADIATION PROTECTION PRINCIPLES FOR SOURCES USED IN RESEARCH AND EDUCATION (2.1).....	4
	Justification of the use of sources in research and education (2.2–2.4)	4
	Optimization of protection and safety in research and education (2.5–2.21)	5
	Dose limits (2.22–2.28)	9
3.	TYPES OF RADIATION SOURCE USED IN RESEARCH AND EDUCATION (3.1)	11
	Sealed sources used in research and education (3.2–3.8)	11
	Unsealed sources used in research and education (3.9–3.16).....	13
	Electrodeposited sources used in research and education (3.17)	16
	Radiation generators used in research and education (3.18–3.23)....	16
4.	ORGANIZATIONAL ARRANGEMENTS FOR RADIATION SOURCES USED IN RESEARCH AND EDUCATION (4.1, 4.2)	17
	Graded approach to radiation safety in the use of sources in research and education (4.3–4.5).....	18
	Responsibilities of operating organizations, registrants and licensees in research and education (4.6–4.10).....	18
	Management system, organizational structure and policies for radiation safety in research and education (4.11–4.16).....	20
	Radiation protection programme for sources used in research and education (4.17–4.22)	22
	Radiation safety committee (4.23–4.26).....	24
	Radiation protection officers in research and education (4.27–4.30) ..	25
	Laboratory radiation protection officers in research and education (4.31).....	27

Qualified experts (4.32, 4.33)	27
Workers and other persons using radiation sources in research and education (4.34–4.41)	27
Control of radioactive sources in research and education (4.42–4.53)	29
Safety culture (4.54–4.56)	32
Human factors (4.57)	33
Process improvement (4.58–4.62)	34
 5. SAFETY ASSESSMENT FOR RADIATION SOURCES USED IN RESEARCH AND EDUCATION (5.1–5.9)	 35
Methods of safety assessment (5.10)	36
Outcomes of the safety assessment (5.11)	37
Review of the safety assessment (5.12–5.14)	38
Record of the safety assessment (5.15, 5.16)	39
 6. DESIGN OF FACILITIES, EQUIPMENT AND RADIATION SOURCES IN RESEARCH AND EDUCATION (6.1–6.5)	 39
Design of laboratories and other facilities for use of radiation sources in research and education (6.6–6.17)	40
Design of equipment containing radiation sources for use in research and education (6.18–6.23)	43
Design of sealed radioactive sources (6.24–6.28)	44
Use of radiation sources in temporary locations (6.29)	45
 7. OCCUPATIONAL RADIATION PROTECTION IN THE USE OF SOURCES IN RESEARCH AND EDUCATION (7.1)	 46
Designation of controlled areas and supervised areas in research and education (7.2–7.11)	46
Local rules for the use of radiation sources in research and education (7.12–7.19)	48
Workplace monitoring in research and education (7.20–7.27)	52
Monitoring and assessment of individual exposure in research and education (7.28–7.41)	54
Records of individual exposure (7.42–7.45)	58
Investigation levels (7.46)	59
Personal protective equipment for the use of sources in research and education (7.47–7.51)	59
Health surveillance programme (7.52–7.57)	61

Information, instruction and training for the use of sources in research and education (7.58–7.67)	62
Conditions of service and special arrangements (7.68–7.73)	64
8. RADIOACTIVE WASTE MANAGEMENT AND DECOMMISSIONING IN RESEARCH AND EDUCATION . . .	66
Management of radioactive discharges in research and education (8.1–8.9)	66
Radioactive waste management in research and education (8.10–8.24)	67
Decommissioning of research and educational facilities (8.25, 8.26) .	72
9. RADIATION PROTECTION OF THE PUBLIC IN THE USE OF SOURCES IN RESEARCH AND EDUCATION (9.1–9.6) . . .	73
10. TRANSPORT AND MOVEMENT OF RADIOACTIVE SOURCES USED IN RESEARCH AND EDUCATION (10.1–10.6)	74
11. EMERGENCY PREPAREDNESS AND RESPONSE FOR RADIATION SOURCES IN RESEARCH AND EDUCATION (11.1–11.7)	76
Emergency plans and procedures for sources in research and education (11.8–11.16)	78
Emergency equipment for sources in research and education (11.17, 11.18)	80
Training and exercises for emergencies involving radiation sources (11.19–11.22)	81
Analysis of emergencies involving radiation sources (11.23, 11.24) .	82
REFERENCES	84
ANNEX I: USE OF NATURALLY OCCURRING RADIOACTIVE MATERIAL IN RESEARCH AND EDUCATION	89
ANNEX II: USE OF RADIATION SOURCES IN SECONDARY SCHOOLS	95

ANNEX III: RADIATION PROTECTION OF STUDENTS IN MEDICAL AND PARAMEDICAL EDUCATION..... 99

ANNEX IV: USE OF SPECIFIC TYPES OF RADIATION SOURCE IN RESEARCH AND EDUCATION..... 103

ANNEX V: EXAMPLE ACTIONS TO CONSIDER IN EMERGENCY PLANS AND PROCEDURES FOR RADIATION SOURCES USED IN RESEARCH AND EDUCATION..... 107

CONTRIBUTORS TO DRAFTING AND REVIEW..... 111

1. INTRODUCTION

BACKGROUND

1.1. IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [1], specifies the basic requirements for the protection of people and the environment from harmful effects of ionizing radiation and for the safety of radiation sources. The implementation of these requirements and all other relevant safety requirements established by the IAEA helps to ensure that the likelihood and magnitude of exposures and the number of individuals exposed are kept as low as reasonably achievable, with economic, societal and environmental factors taken into account. It also helps to prevent accidents involving radiation sources and, if such accidents occur, to mitigate their consequences. This Safety Guide provides recommendations for implementing the requirements in GSR Part 3 [1] with regard to the use of radiation sources in research and education.

1.2. Many types of radiation source are used in research and education. The sources include particle accelerators; sealed radioactive sources, such as low activity check sources and high activity sealed radioactive sources in irradiators; unsealed radioactive sources used as tracers in field work and in laboratory work; naturally occurring radioactive material; and X ray generators such as diffraction apparatuses and fluorescence analysers.

1.3. The users of radiation sources include secondary school students, undergraduate students, graduate students, technical staff, research staff and academic staff. The graduate students, research staff and academic staff often work on more than one campus and may also undertake research work in other countries.

1.4. The use of radioactive sources can lead to the generation of radioactive waste that needs to be managed by the educational or research facility or activity. Radioactive material and radioactive waste may need to be transported between laboratories on a campus or between campuses. Some radioactive waste needs to be stored to allow it to decay before being transferred to a waste management organization for treatment and disposal.

1.5. This Safety Guide is part of a set of Safety Guides that cover the use of radiation sources in industrial irradiators, industrial radiography, inspection and

non-medical imaging, well logging, nuclear gauges, and accelerator based isotope production facilities [2–7].

1.6. Detailed recommendations on occupational radiation protection can be found in IAEA Safety Standards Series No. GSG-7, Occupational Radiation Protection [8]. Recommendations on the protection of the public and the environment are provided in IAEA Safety Standards Series No. GSG-8, Radiation Protection of the Public and the Environment [9]. Requirements and recommendations for radiation protection in emergency exposure situations are provided in IAEA Safety Standards Series Nos GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency [10]; GSG-2, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency [11]; GS-G-2.1, Arrangements for Preparedness for a Nuclear or Radiological Emergency [12]; and GSG-11, Arrangements for the Termination of a Nuclear or Radiological Emergency [13].

1.7. It is assumed in this Safety Guide that the State has an effective governmental, legal and regulatory infrastructure for radiation safety that covers the use of radiation sources in research and educational facilities and activities. Requirements for such infrastructure are established in IAEA Safety Standards Series No. GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety [14], and recommendations on the implementation of these requirements are provided in Refs [15–17].

OBJECTIVE

1.8. The objective of this Safety Guide is to provide recommendations on how to meet the relevant requirements of GSR Part 3 [1] in the use of radiation sources in research and education. This includes recommendations on the control of occupational exposure and of public exposure for planned exposure situations and, where appropriate, emergency exposure situations as well as on specific safety measures.

1.9. The recommendations in this Safety Guide are aimed primarily at operating organizations such as educational and research establishments, including schools, colleges, universities and technical institutes, that are authorized to use radiation sources in academic programmes, as well as their employees, students, teachers and radiation protection officers. The recommendations will also be of interest to regulatory bodies and to other relevant organizations involved in the design, manufacture, supply and service of radiation sources and associated equipment for research and education.

SCOPE

1.10. This Safety Guide addresses the radiation protection and safety aspects of the use of radioactive sources and radiation generators in research and education.

1.11. This Safety Guide addresses the exposure of students and workers using radiation sources in research and education. It also covers the exposure of members of the public who might be inadvertently exposed during the use of such sources.

1.12. The exposure of volunteers for the purposes of biomedical research is considered a medical exposure. Recommendations on such exposures are provided in IAEA Safety Standards Series No. SSG-46, Radiation Protection and Safety in Medical Uses of Ionizing Radiation [18].

1.13. Requirements relating to the protection of students and research workers carrying out research or studies at research reactors are established in IAEA Safety Standards Series No. SSR-3, Safety of Research Reactors [19], and related recommendations are provided in IAEA Safety Standards Series No. SSG-85, Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors [20]. Such facilities and activities are outside the scope of this Safety Guide.

1.14. This Safety Guide also provides information on the need for appropriate nuclear security measures and on their interface with safety measures but does not provide specific guidance on such nuclear security aspects. Additional security guidance can be found in the IAEA Nuclear Security Series.

STRUCTURE

1.15. Section 2 describes the basic principles of radiation protection and their application in the protection of students, research workers and members of the public in research and education. The types of radiation source used in research and education are described in Section 3. Recommendations on the duties and responsibilities of the operating organization, radiation safety committee, radiation protection officer and qualified experts, and on the content of a radiation protection programme, are provided in Section 4. Recommendations on the preparation of a safety assessment are provided in Section 5. Section 6 provides recommendations on the design of facilities, laboratories, equipment and sources. Section 7 provides recommendations on arrangements for occupational radiation protection, including classification of areas, local rules, monitoring of the

workplace, assessment of occupational exposure, health surveillance and training. Section 8 provides recommendations on the discharge of radioactive material from laboratories and on the management of radioactive waste and decommissioning. Section 9 provides recommendations on protection of members of the public. Section 10 provides recommendations on the movement of radioactive material within a site and on the transport of radioactive material to and from different sites. Section 11 provides recommendations on the arrangements for prevention of accidents and mitigation of their consequences and on the preparation of emergency plans and procedures.

1.16. Annex I provides practical guidance on the use of naturally occurring radioactive material (NORM) in research and education. The use of radiation sources in secondary schools raises specific issues, for example in relation to the age of students; therefore, Annex II provides practical guidance on the use of radiation sources in secondary schools. Annex III provides case studies and practical guidance on the radiation protection of students in medical and paramedical education. Annex IV gives information on the safe use of specific types of radiation source in research and education. Annex V provides examples of specific on-site actions to be considered in emergency plans and procedures for certain emergencies relating to the use of sources in research and education.

2. RADIATION PROTECTION PRINCIPLES FOR SOURCES USED IN RESEARCH AND EDUCATION

2.1. Requirement 1 of GSR Part 3 [1] specifies that those responsible for protection and safety in facilities handling radiation sources are required to ensure that the principles of radiation protection are applied. These principles are justification of practices, optimization of protection and safety, and dose limitation, as stipulated in Requirements 10–12 of GSR Part 3 [1].

JUSTIFICATION OF THE USE OF SOURCES IN RESEARCH AND EDUCATION

2.2. Paragraph 3.16 of GSR Part 3 [1] states (footnotes omitted):

“The government or the regulatory body, as appropriate, shall ensure that provision is made for the justification of any type of practice and for review

of the justification, as necessary, and shall ensure that only justified practices are authorized.”

This means that no practice is to be authorized unless the practice produces sufficient benefit to the exposed individuals or to society to offset any harm that the exposure to radiation might cause.

2.3. The process of determining whether a practice is justified involves a full characterization of the radiation sources that will be used and the measures that will be taken to ensure safety, and an assessment of the radiation detriment in terms of the expected exposures from normal use of the sources and the magnitude and likelihood of potential exposures from accidents. The assumption is made in this Safety Guide that the process of justification has already taken place. The justification process should have specified the types of source and the type of practice, for example the type and activities of radiation sources that are permitted to be used in secondary schools. The justification of practices and sources should be reviewed, as necessary.

2.4. Recommendations on the application of the principle of justification are provided in IAEA Safety Standards Series No. GSG-5, Justification of Practices, Including Non-medical Human Imaging [21]. For research organizations developing new technologies involving the use of radiation sources, GSG-5 [21] sets out the elements that should be considered and the process that should be applied in determining whether the introduction of a particular type of practice is justified.

OPTIMIZATION OF PROTECTION AND SAFETY IN RESEARCH AND EDUCATION

2.5. Paragraph 3.23 of GSR Part 3 [1] states that “Registrants and licensees shall ensure that protection and safety is optimized.” This means that the process of optimization of protection and safety has been applied and the result of that process has been implemented. Guidance on the application of the principle of optimization of protection and safety in the control of occupational exposure can be found in Ref. [22]. The intended outcome of the optimization of protection and safety is that all exposures are controlled to levels that are as low as reasonably achievable, economic, societal and environmental factors being taken into account.

2.6. Optimization of protection and safety needs to be considered at all stages in the lifetime of facilities and activities, in relation to both exposures from normal

operations and potential exposures. Therefore, all situations — from design through operation to decommissioning, transport and waste management — should be considered in the optimization process.

2.7. In practice, the optimization of protection and safety for sources used in research and education calls for an approach that should include the following:

- (a) Consideration of all possible actions by workers and students involving the sources.
- (b) Implementation of a ‘management by objective’ process with the following sequence: planning, setting objectives, monitoring, measuring performance, evaluating and analysing performance to define corrective actions, record keeping and setting new objectives.
- (c) Ability to take into account any significant changes in technology or techniques and the prevailing social context.
- (d) Accountability, such that all parties adopt a responsible attitude to the process of eliminating unnecessary exposures.

2.8. The process of optimization of protection and safety should take into account the following:

- (a) The resources available for protection and safety;
- (b) The distribution of individual and collective exposure among different groups of workers and students;
- (c) The probability and magnitude of potential exposures;
- (d) The potential impact of protection options on the level of other (non-radiological) risks to workers or members of the public;
- (e) Good practices in relevant sectors;
- (f) Societal and economic aspects.

2.9. The optimization of protection and safety for radiation sources used in research and education should be considered at the design stage of equipment and facilities, such as laboratories, when some degree of flexibility is still available and a graded approach that is commensurate with the radiation risk can be applied. The use of engineered controls should be examined carefully at this stage when defining the protection options. Decisions made at the design stage include the design of shielding, of ventilation systems and fume hoods of laboratories and of instrumentation including safety systems.

2.10. The content and scale of the optimization process will depend on the type and nature of the facilities and activities involving radiation sources. For

example, for low activity sealed radioactive sources or for X ray equipment fitted with effective engineered controls, the optimization process can be quite straightforward, involving local rules and appropriate training of the users. For laboratories using complex equipment, or for activities involving complicated source handling procedures, a structured approach should be applied including, where appropriate, the use of decision aiding techniques.

2.11. Some of the options considered in the optimization of the protection and safety of workers might lead to increased exposure of other persons, such as students, the general staff working in the facility and visitors. Such effects should be taken into account in the optimization process, especially when considering the establishment of administrative controls and the use of personal protective equipment.

2.12. In general, the incremental benefits to be obtained in terms of dose reduction decrease progressively as the associated expenditure increases. Even the cost of considering the ways in which exposures may be reduced can become significant compared with the benefit to be achieved. At some stage, for sources used in research and education that pose a low radiation risk, the effort might not be worthwhile.

2.13. Even if protection has been optimized at the design stage, there is still a need to optimize protection and safety during the operation of a facility or the conduct of an activity. Optimization of protection and safety in operation is a process that begins at the planning stage and continues through the stages of scheduling, preparation, implementation and feedback. This process of optimization through work management should be applied to keep exposures under review and to ensure that they are as low as reasonably achievable. The establishment of a radiation protection programme (see paras 4.17–4.22) is an essential element of work management.

2.14. The operating organization should record information on the way in which optimization of protection and safety is being implemented for the radiation sources used in research and education and should disseminate this information where appropriate. This information could include the following:

- (a) The rationale for the proposed operating, maintenance and administrative procedures, including for the purchase, transport, storage and disposal of sources, together with other options considered and the reason for their rejection;

- (b) Periodic reviews and analysis of trends in the exposure of individuals, and other performance indicators;
- (c) The results of internal audits and peer reviews;
- (d) Incident reports and lessons learned.

Dose constraints

2.15. Dose constraints are required to be used for the optimization of protection and safety (see paras 1.22 and 3.25 of GSR Part 3 [1]). Dose constraints are applied to occupational exposure and to public exposure in planned exposure situations. For occupational exposure, a dose constraint is a source related value of individual dose used to limit the range of options considered in the process of optimization and will always be a fraction of the dose limit. Dose constraints are set separately for each source under control and serve as boundary conditions in defining the range of options for the purposes of optimization. Dose constraints are not dose limits; exceeding a dose constraint does not represent non-compliance with regulatory requirements, but it could result in follow-up actions.

2.16. While the objectives of the use of dose constraints for controlling occupational exposure and public exposure are similar, the dose constraints are applied in different ways. For occupational exposure, the dose constraint is a tool to be established and used by the licensee responsible for radiation sources in the optimization of protection and safety. The setting of dose constraints needs to be considered in conjunction with other health and safety provisions and the technology available. For public exposure, the relevant dose constraint is a source related value established or approved by the government or the regulatory body, with account taken of the doses from planned operations of all sources under control. The dose constraint for individual sources is intended, among other things, to ensure that the sum of doses from planned operations for all sources under control remains within the dose limit (see footnote 25 to GSR Part 3 [1]).

2.17. The objective of a dose constraint is to place a ceiling on values of individual dose — from a source, a set of sources in a facility, a practice, a task or a group of operations in a specific type of industry — that could be considered acceptable in the process of optimization of protection for those sources, practices or tasks. Depending on the situation, the constraint can be expressed as a single dose or as a dose over a given time period. The setting of dose constraints should be such that dose limits for occupational exposure are complied with when workers incur exposures from multiple sources or tasks.

2.18. To apply the optimization principle, individual doses should be estimated at the design and planning stage, and it is these predicted individual doses for the various options that should be compared with the appropriate dose constraint. Options predicted to give doses below the dose constraint should be considered further; those predicted to give doses above the dose constraint would normally be rejected. Dose constraints should be used prospectively in optimizing radiation protection in planning and executing activities and in designing facilities or equipment. Dose constraints should, therefore, be set on a case by case basis in accordance with the specific characteristics of the source of exposure.

2.19. Since dose constraints are source related, the source to which they relate should be specified. Dose constraints should be set in consultation with those involved in the facility or activity. For students, the dose constraint should take account of the number of hours the students will be using radiation sources. For research workers, the dose constraint would need to take account of the time they spend using radiation sources at their ‘home’ campus and of the time they spend using other sources in other facilities.

2.20. For members of the public, the dose constraint is a fraction of the public dose limit and is to be used in designing shielding (e.g. for radiation sources and associated equipment, laboratories, and stores for radioactive sources and radioactive waste) and in determining discharge limits.

2.21. Dose constraints should not be used retrospectively to check compliance with the requirements for protection and safety. However, para. 1.23 of GSR Part 3 [1] states:

“After exposures have occurred, the dose constraint may be used as a benchmark for assessing the suitability of the optimized strategy for protection and safety (referred to as the protection strategy) that has been implemented and for making adjustments as necessary.”

DOSE LIMITS

2.22. The dose limits for planned exposure situations are specified in schedule III of GSR Part 3 [1] and, for convenience, are reproduced in paras 2.23–2.26 of this Safety Guide. Associated requirements are specified in paras 3.26–3.28 of GSR Part 3 [1].

2.23. For occupational exposure of workers over the age of 18 years, the dose limits are as follows:

- (a) An effective dose of 20 mSv per year averaged over five consecutive years (100 mSv in five years) and of 50 mSv in any single year;
- (b) An equivalent dose to the lens of the eye of 20 mSv per year averaged over five consecutive years (100 mSv in five years) and of 50 mSv in any single year;
- (c) An equivalent dose to the extremities (hands and feet) or to the skin of 500 mSv in a year.

Additional restrictions apply to occupational exposure for a worker who has notified their employer that they are pregnant or breastfeeding (see para. 3.114 of GSR Part 3 [1] and paras 6.2–6.20 of GSG-7 [8]).

2.24. For occupational exposure of apprentices of 16–18 years of age who are being trained for employment involving radiation and for exposure of students of 16–18 years of age who use sources in the course of their studies, the dose limits are as follows:

- (a) An effective dose of 6 mSv in a year;
- (b) An equivalent dose to the lens of the eye of 20 mSv in a year;
- (c) An equivalent dose to the extremities (hands and feet) or to the skin of 150 mSv in a year.

2.25. For public exposure, the dose limits are as follows:

- (a) An effective dose of 1 mSv in a year.
- (b) In special circumstances, a higher value of effective dose in a single year could apply, provided that the average effective dose over five consecutive years does not exceed 1 mSv per year.
- (c) An equivalent dose to the lens of the eye of 15 mSv in a year.
- (d) An equivalent dose to the skin of 50 mSv in a year.

2.26. The equivalent dose limits for the skin specified in paras 2.23–2.25 apply to the average dose over 1 cm² of the most highly irradiated area of the skin. The dose to the skin also contributes to the effective dose, this contribution being the average dose to the entire skin multiplied by the tissue weighting factor for the skin.

2.27. The dose limits apply to all users of radiation sources, including short term contractors, research workers and students. Notwithstanding the dose limits

specified for students in para. 2.24, ideally secondary school students (typically up to the age of 17 or 18 years) and undergraduate students (typically up to the age of 21 or 22 years) should receive the same level of protection and safety as members of the public. There is a general expectation that a high level of protection will be provided for younger students. Compliance with the dose limits for public exposure is normally straightforward, as these students are likely to be using radiation sources for only a few hours per year.

2.28. Graduate and postgraduate students (typically above the age of 22 years) conducting research or studies using radiation sources for long duration should be afforded the same level of protection and safety as workers. Registrants and licensees should establish a system to ensure that the total annual radiation exposure of research workers and graduate students, including any exposure received by them when they are using radiation sources at other research organizations, does not exceed the dose limits for occupational exposure. In addition, registrants and licensees should make arrangements for pregnant or breastfeeding research workers or graduate students to meet the requirements of para. 3.114 of GSR Part 3 [1].

3. TYPES OF RADIATION SOURCE USED IN RESEARCH AND EDUCATION

3.1. A wide variety of radiation sources are used in research and education. These sources include sealed radioactive sources, unsealed radioactive material, and radiation generators such as X ray units, accelerators and neutron generators. Radioactive sources may be used in teaching basic science principles in secondary schools or used in the teaching of undergraduate students at universities. The sources can be used to test radiation monitoring instruments (e.g. as used in research laboratories and secondary schools for demonstrations). Radiation sources in research activities can be used by undergraduate students, graduate research students and research scientists.

SEALED SOURCES USED IN RESEARCH AND EDUCATION

3.2. A large variety of sealed sources are used in research and education. A sealed source is a radioactive source in which the radioactive material is (a) permanently sealed in a capsule or (b) closely bonded and in a solid form [23]. In research and

education, sealed sources are generally longer half-life radioactive material firmly contained or bound within a suitable capsule or housing. As such, sealed sources represent a possible external radiation hazard: such sources only present a risk of internal radiation exposure (i.e. due to contamination) if they have been breached or are leaking. The radionuclides and activities of such sources vary depending on the application; sealed sources may be used as sample irradiators or calibration sources or in scientific equipment.

3.3. Sealed sources should meet the following criteria:

- (a) Sealed sources should be designed, manufactured and tested to meet the requirements of the appropriate International Organization for Standardization (ISO) standard [24] or an equivalent national standard. These standards set out the normal operating conditions and accident conditions that a sealed source should withstand.
- (b) Sealed sources should be periodically leak tested in accordance with the appropriate ISO standard [25] or an equivalent national standard and should be issued with a valid leak test certificate that is traceable to a standards laboratory.
- (c) Where appropriate, sealed sources should be certified as meeting the requirements for ‘special form radioactive material’ as established in IAEA Safety Standards Series No. SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material, 2018 Edition [26].

3.4. A categorization system for ranking radioactive sources in terms of their potential to cause harm to human health, and for grouping sources and the practices in which they are used, is provided in IAEA Safety Standards Series No. RS-G-1.9, Categorization of Radioactive Sources [27]. This categorization can assist in establishing regulatory requirements to ensure an appropriate level of safety and security control for each authorized source.

3.5. Sealed sources may be used to calibrate radiation measurement equipment (e.g. area radiation monitors, spectrometers, contamination measuring instruments, analytical radiation measuring equipment). Depending on the instrument to be calibrated, a wide range of radionuclides (e.g. ^{60}Co , ^{137}Cs , ^{241}Am -Be, ^{210}Po , ^{90}Sr) that emit alpha, beta, gamma or neutron radiation may be used. The activity of the source is dependent on the application and ranges from a few kilobecquerels for check sources to several terabecquerels for some sources used in calibrations. It is possible for some check sources to be exempted from regulatory authorization owing to their low activity. However, even with these small sources, best practice guidelines for radiation protection should be employed to minimize the risk

of exposure to workers, students, the public and the environment. Calibration sources (e.g. ^{68}Ge , ^{57}Co , ^{22}Na) are also commonly used to test equipment used in microPET (micro positron emission tomography) and microSPECT (micro single photon emission computed tomography) imaging techniques.

3.6. Sample irradiators are used to irradiate different types of sample, such as metals, plastics, cells, tissue samples, plants or small animals, to study the effects of radiation exposure. The radionuclides usually employed are gamma ray emitters (e.g. ^{60}Co , ^{137}Cs). However, some sample irradiators are specifically designed to expose materials to alpha or beta radiation using plated or laminated sources. Such sources should be handled with special care to minimize the risk of causing a release of the radioactive material (see also para. 3.17). The activity of sources used in irradiators ranges from a few kilobecquerels to several terabecquerels.

3.7. Sealed sources may be used in scientific or measurement equipment such as liquid scintillation counters. In the academic and research environment, these sources may be commercial sealed sources or specially constructed sources integrated into commercially available instruments or other equipment, depending on the application. The radiation exposure of users of commercial instruments is generally very low; it should be ensured that instruments that have been designed ‘in house’ achieve a similar level of protection and safety. The main risks of exposure from these sources are due to improper handling, loss of source integrity, or loss or uncontrolled release of the source or the instrument incorporating the source. Some of these sources might be exempted from regulation owing to low activity. Nevertheless, the instrument and the source should be marked with the radiation symbol (trefoil) [28], the word ‘RADIOACTIVE’ and a description of the source, including the serial number.

3.8. Neutron sources are used in the calibration of instruments, in the creation of fission reactions in experimental reactors, in nuclear physics research (e.g. neutron logging, neutron diffraction analysis), in the demonstration of physics principles and in neutron activation analysis. Common nuclides in neutron sources are ^{252}Cf (spontaneous fission), ^{241}Am -Be (α , n reaction) and ^{124}Sb -Be (γ , n reaction). The safety of neutron sources normally involves shielding against both neutron and photon radiation.

UNSEALED SOURCES USED IN RESEARCH AND EDUCATION

3.9. An unsealed source is a radioactive source in which the radioactive material is neither (a) permanently sealed in a capsule nor (b) closely bonded and in a

solid form [23]. These materials are extensively used in research and education. Applications include physics experiments, tracers in biomedical or environmental studies, and various uses in radiochemistry laboratories. The radioactive material may be in different physical forms, such as a liquid for environmental transfer studies, a gas for atmospheric research or an activated solid sample in physics research. A variety of radionuclides with a very wide range of activities is used in research facilities. For example, the activity of radioactive liquids used in laboratories can range from a few becquerels to multiple gigabecquerels with a high specific activity that is often diluted for further use in the laboratory. Research work involving the use of unsealed sources in animal experiments may also be conducted.

3.10. The use of unsealed sources can give rise to both internal exposure and external exposure during experiments or laboratory work or due to events that lead to dispersal of the radioactivity resulting in contamination of persons, the workplace, equipment or the environment. Depending on the physical characteristics of the unsealed source and the activities involved, the radioactivity could be released as a gas, liquid or solid. As a result, the nature, spread and magnitude of the contamination risk depend on the radionuclides and activity, the chemical and physical forms of the material involved, and the dispersal method.

3.11. Unsealed alpha emitters (e.g. natural uranium, natural thorium, ^{239}Pu , ^{241}Am) are used in radioecological or radiation protection studies, environmental monitoring such as radon measurements, basic science research, and biomedical and medical research. Such sources may be used in a particulate or liquid form. The activity used is often very small (a few becquerels to megabecquerels); however, there is still potential for significant internal exposure from ingestion and (especially) inhalation. Alpha emitters are difficult to detect unless the source also emits a more readily measured radiation such as gamma rays. In artificial sources, the radioactive material may be present as a liquid or powder; natural sources may include radon and thoron gas.

3.12. Beta emitters (e.g. ^3H , ^{14}C , ^{32}P) are often used as molecular labels or tracers in biological or environmental studies. The activities used vary from a few kilobecquerels to megabecquerels. Beta emitters are generally grouped into two categories: low energy ($E_{\text{max}} < 150 \text{ keV}$) and high energy ($E_{\text{max}} > 150 \text{ keV}$). Generally, the radiation risk associated with beta emitters is lower than for alpha emitters, but care should be taken to protect the skin and the lens of the eye against external exposure from high energy beta emitters. For low energy beta emitters (e.g. ^3H , ^{14}C), higher activities are often used in experiments. As a result, exposure to these low energy beta emitters is controlled by minimizing the spread of

contamination and by using personal protective equipment. Tritium (^3H) is widely used in research and is present as a contaminant in accelerator environments; it can also enter the body by skin absorption, for example owing to skin contamination or to contact with contaminated materials such as metals and plastics.

3.13. Unsealed gamma emitters (e.g. ^{125}I , ^{131}I , ^{133}Xe , ^{60}Co , ^{137}Cs) may be used in environmental research applications and are widely used in laboratories undertaking biological and medical research involving positron emitters (e.g. ^{18}F , ^{11}C). In nuclear medicine applications, it is desirable to use radionuclides with short half-lives. However, some research work may be performed using radionuclides with long half-lives to study the material's biological properties. Unsealed gamma emitters may also present an external exposure risk. It may be necessary to consider both whole body and hand exposure when materials are handled, for example in flasks or syringes.

3.14. Environmental research may involve the use of unsealed radioactive sources in the form of radiotracers to study processes and interactions such as sediment transport, water currents, or effluent distribution. Such studies involve the deliberate and controlled release of unsealed sources to the environment. A detailed safety assessment (see Section 5), including a prospective environmental impact assessment, is necessary.

3.15. NORM¹ is used in educational and research establishments, including the display or use of minerals containing NORM in class demonstrations in secondary schools and research projects involving NORM in universities or research centres. Laboratory activities that may involve NORM include the analysis of raw materials, products and residues; process related research; research for the recycling or reuse of NORM residues, waste conditioning and management, and decontamination of processing facilities and equipment; and the construction and operation of pilot plants. In many cases, research using NORM is part of an industrial activity and may be performed in a specific laboratory at an industrial site or in a separate off-site laboratory. Research may also be undertaken at university laboratories or at technical support organizations. Further information on laboratories using NORM is provided in Annex I.

¹ NORM is defined as a radioactive material containing no significant amounts of radionuclides other than naturally occurring radionuclides. Material in which the activity concentrations of the naturally occurring radionuclides have been changed by a process is included in naturally occurring radioactive material (NORM) [23].

3.16. Laboratories that provide calibration and equipment testing services for the measurement of radon contain radon chambers of various sizes, from smaller than 1 m³ to tens of cubic metres. These chambers contain a source of radon gas.

ELECTRODEPOSITED SOURCES USED IN RESEARCH AND EDUCATION

3.17. Plated radioactive sources where a thin layer of radioactivity is electrodeposited on a non-radioactive surface are also used in some applications in research and education. They present a greater potential contamination hazard than the same amount of material as a sealed source but less than the same amount of material in unsealed form. Electrodeposited sources (e.g. ³H, ⁹⁰Sr, ⁶³Ni, ²²⁶Ra, ⁵⁷Co) are used in electron capture detectors in gas chromatography units and in the efficiency determination of some alpha scintillation detection instruments.

RADIATION GENERATORS USED IN RESEARCH AND EDUCATION

3.18. Low energy X rays are used in diffraction and spectroscopy applications to investigate the structure of materials. While the energy of these beams means that shielding can readily be provided, there is a significant hazard if access to the beam is possible. Care should be taken during experiments involving access to such X ray beams to avoid extremity doses.

3.19. X rays can also be produced by an apparatus in which high speed electrons strike a target in a (partial) vacuum. Some examples, such as Crookes tubes and other cold cathode discharge tubes, are described in Annex II. In electron microscopy, any X rays produced are generally well shielded by the microscope and associated housings.

3.20. Handheld X ray devices are used to identify materials on the basis of their characteristic X rays. These handheld devices can produce very intense but narrow X ray beams. If the user modifies the shielding or places a part of the body into the beam, significant exposures might result.

3.21. X rays are also used in research and education to generate an image (e.g. of materials, objects, people or animals). The devices used range from handheld X ray generators to fixed devices in shielded cabinets or rooms that incorporate shielding and safety systems to protect users and other persons. Computed tomography uses a narrow high intensity X ray beam to produce cross-sectional

and 3-D images; it is used in applications such as biomedical research, materials analysis and anthropology. Fluoroscopy uses X rays to produce real-time images; it is used in research to view the movement and functioning of the system under investigation. Annex III provides examples of measures for radiation protection of students in medical and paramedical education programmes.

3.22. X rays are also used to irradiate materials and other objects, for example to deliberately create radiation damage for research purposes. High levels of radiation are needed, and the X ray beam is generated in a shielded cabinet or room that incorporates shielding and safety systems to protect users and other persons.

3.23. Accelerators may be used for medical purposes as well as for physics and materials science research. The radiation hazards associated with these devices include the primary and secondary radiation (e.g. X rays, electrons, neutrons) produced during operation. Shielding materials with low atomic numbers should be used to minimize the production of secondary X rays (bremsstrahlung). Many of these facilities produce radiation fields of sufficient energy to make the structural components of the accelerator radioactive, and access to the area around the device may need to be controlled both during and after operation. The potential for release of radioactive material into the air, and for activation of air and/or components of the facility, should be considered. The arrangements for managing activated components and for decommissioning of the facility should also be considered. Specific recommendations on accelerator based isotope production facilities are provided in IAEA Safety Standards Series No. SSG-59, Radiation Safety of Accelerator Based Radioisotope Production Facilities [7].

4. ORGANIZATIONAL ARRANGEMENTS FOR RADIATION SOURCES USED IN RESEARCH AND EDUCATION

4.1. GSR Part 3 [1] establishes requirements on duties and responsibilities relating to the use of radiation sources. This section provides recommendations on the duties and responsibilities of relevant parties in relation to the use of radiation sources in research and education.

4.2. The use of radiation sources in research and education will take place within a legal and regulatory framework within the State. The government will have

established a legal framework that includes the establishment of a regulatory body. The responsibilities of the regulatory body include the development of regulations and user guides, the exemption or authorization of practices, the review and assessment of applications for authorization, the inspection of facilities and activities, and the enforcement of the regulations and law relating to radiation safety.

GRADED APPROACH TO RADIATION SAFETY IN THE USE OF SOURCES IN RESEARCH AND EDUCATION

4.3. Paragraph 2.12 of GSR Part 3 [1] states that “The application of the requirements for the system of protection and safety shall be commensurate with the radiation risks associated with the exposure situation.”

4.4. GSR Part 3 [1] places responsibilities for a graded approach on the government, the regulatory body, registrants and licensees, and employers. The government and the regulatory body are required to use the graded approach in establishing and enforcing regulatory requirements, such as the processes for justification and for authorization (see paras 2.18 and 2.31 of GSR Part 3 [1]).

4.5. Registrants and licensees, and employers are required to use a graded approach in the measures they take for protection and safety (see Requirement 6 of GSR Part 3 [1]). For example, university departments with accelerators or research irradiators, and laboratories using unsealed radioactive material that generates radioactive waste, would be expected to have a more detailed safety assessment (see Section 5 of this Safety Guide) and more extensive local rules (see paras 7.12–7.19) than a department with a few check sources or a secondary school that has a very limited number of low activity radioactive sources.

RESPONSIBILITIES OF OPERATING ORGANIZATIONS, REGISTRANTS AND LICENSEES IN RESEARCH AND EDUCATION

4.6. The operating organization is the organization that is applying for authorization or that is authorized to operate a facility and is responsible for its safety [23]. Authorization can take the form of either registration or licencing (see para. 3.8 of GSR Part 3 [1]). Consequently, the term ‘operating organization’ includes registrants and licensees, including individual persons where appropriate.

4.7. Requirement 4 of GSR Part 3 [1] states:

“The person or organization responsible for facilities and activities that give rise to radiation risks shall have the prime responsibility for protection and safety. Other parties shall have specified responsibilities for protection and safety.”

4.8. Paragraph 2.39 of GSR Part 3 [1] states that “The person or organization responsible for any facility or activity that gives rise to radiation risks shall have the prime responsibility for protection and safety, which cannot be delegated.”

4.9. The principal parties responsible for protection and safety with regard to the use of radiation sources in research or education are as follows:

- (a) The educational or research entity responsible for the facility or activity in which the radiation sources are stored or used.
- (b) Employers and/or academic or research managers who have direct operational oversight of the radiation sources. For most academic and research staff, the employer is (or is part of) the operating organization. Some academic staff and researchers undertake research at more than one organization. Consequently, these persons may have one employer but use radiation sources owned by more than one operating organization. It is also common for researchers to receive assistance from students (i.e. who are not employed) during their education.

4.10. Other parties have specified responsibilities for protection and safety in support of the operating organization’s responsibilities (see para. 2.41 of GSR Part 3 [1]). With regard to the use of radiation sources in research or education, these parties include the following:

- (a) Radiation protection officers (see paras 4.27–4.31);
- (b) Qualified experts (see paras 4.32 and 4.33);
- (c) Users of radiation sources, such as academic staff, research workers and students;
- (d) External service providers, such as suppliers (e.g. of sealed sources, unsealed radioactive material and radiation generators), dosimetry services, and organizations providing support for the transport of radioactive material and the disposal of radioactive waste.

MANAGEMENT SYSTEM, ORGANIZATIONAL STRUCTURE AND POLICIES FOR RADIATION SAFETY IN RESEARCH AND EDUCATION

4.11. Requirement 5 of GSR Part 3 [1] states that **“The principal parties shall ensure that protection and safety are effectively integrated into the overall management system of the organizations for which they are responsible.”** Requirements for the management system are established in IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [29].

4.12. Paragraph 2.47 of GSR Part 3 [1] states that “The principal parties shall demonstrate commitment to protection and safety at the highest levels within the organizations for which they are responsible.”

4.13. Paragraph 2.48 of GSR Part 3 [1] states (footnote omitted):

“The principal parties shall ensure that the management system is designed and applied to enhance protection and safety by:

- (a) Applying the requirements for protection and safety coherently with other requirements, including requirements for operational performance, and coherently with guidelines for security;
- (b) Describing the planned and systematic actions necessary to provide adequate confidence that the requirements for protection and safety are fulfilled;
- (c) Ensuring that protection and safety are not compromised by other requirements;
- (d) Providing for the regular assessment of performance for protection and safety, and the application of lessons learned from experience;
- (e) Promoting safety culture.”

4.14. Paragraph 2.50 of GSR Part 3 [1] states that “The principal parties shall be able to demonstrate the effective fulfilment of the requirements for protection and safety in the management system.”

4.15. The management system is required to include a description of the organizational structure as it relates to radiation safety (see paras 4.11 and 4.16 of GSR Part 2 [29]). This structure, which may be presented in the form of an organizational chart, should show the names of the relevant radiation protection officers or units (see paras 4.27–4.31 of this Safety Guide), the radiation safety committee (see paras 4.23–4.26) and its members, and interfaces with other

relevant parties within the research or educational facility. The chart should clearly show the line of reporting. An example of an organizational chart for a large research or educational facility, with multiple departments and laboratories using radiation sources, which may be spread across more than one site, is shown in Fig. 1. For smaller research or educational facilities, the chart can be simpler but should still show the relevant responsible persons, for example a radiation protection officer and one or more qualified experts, as necessary.

4.16. In research organizations that use radiation sources, persons from multiple organizations may work together; equally, persons from one organization may use radiation sources at a number of different organizations. Under these conditions, the management system should clearly specify the persons responsible for the safety of workers and other persons at each location. If responsibilities are shared, the division of responsibilities should be defined in the management system. Examples of these extended organizations include the following cases:

- (a) The operating organization has more than one location of operation.
- (b) Several operating organizations share the same location of operation.
- (c) The worker is employed by several different organizations.
- (d) The worker is not employed by or affiliated with the operating organization.
- (e) The worker is engaged in experiments that involve sources that are not under the control of the employer.

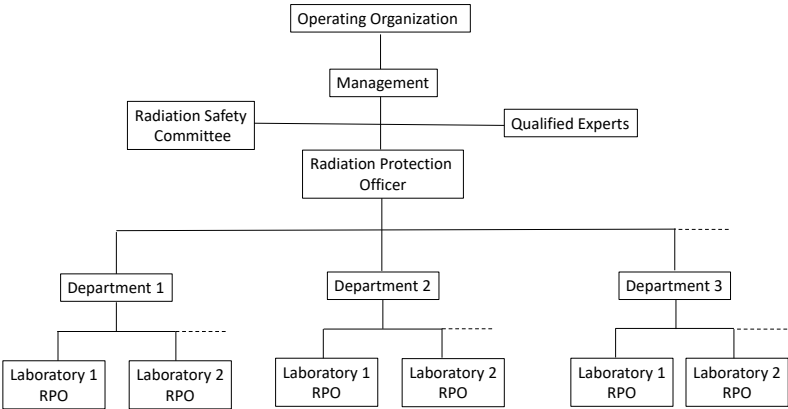


FIG. 1. Example of an organizational chart for radiation safety in a large research or educational facility. RPO — radiation protection officer.

RADIATION PROTECTION PROGRAMME FOR SOURCES USED IN RESEARCH AND EDUCATION

4.17. Requirement 24 of GSR Part 3 [1] states:

“Employers, registrants and licensees shall establish and maintain organizational, procedural and technical arrangements for the designation of controlled areas and supervised areas, for local rules and for monitoring of the workplace, in a radiation protection programme for occupational exposure.”

4.18. The operating organization should ensure that in the implementation of the radiation protection programme the following are addressed:

- (a) The measures and resources necessary for achieving the objectives for protection and safety have been determined and are duly provided.
- (b) The programme is periodically reviewed to assess its effectiveness and its continued fitness for purpose by considering and incorporating feedback from operating experience and lessons learned.
- (c) Any failures or shortcomings in protection and safety are identified and corrected, and steps are taken to prevent their recurrence.
- (d) Arrangements are made to consult with relevant interested parties.
- (e) Appropriate records are maintained.

4.19. The roles of the radiation protection officer and the radiation safety committee should be clearly defined in the radiation protection programme. The radiation protection officer and the radiation safety committee should oversee the effectiveness of the radiation protection programme and inform the management of the facility as appropriate.

4.20. The radiation protection programme should be customized and scaled to meet the needs of the operating organization. The programme should reflect the complexities and hazards associated with the radiation sources and the education and research activities to be conducted. The programme should be based on the operating organization’s safety assessment (see Section 5), and it should address both normal use of the radiation sources and accidents.

4.21. Recommendations on the content of a radiation protection programme are provided in paras 3.49–3.158 of GSG-7 [8]. For sources used in research and

education, the radiation protection programme should cover the main elements contributing to protection and safety, including the following:

- (a) Reference to the management system, including the management structure and policies and the assignment of individual responsibilities for radiation safety.
- (b) Reference to the results of the safety assessment (see Section 5).
- (c) Arrangements for control of radiation sources.
- (d) Arrangements for protection of workers and other persons (e.g. students) who might use the radiation sources. Such arrangements include local rules; designation of controlled or supervised areas; arrangements for the monitoring of persons, the workplace and the environment; and, where appropriate, a health surveillance programme (see paras 7.52–7.57).
- (e) The education and training programme on the nature of the radiation hazards, the radionuclides involved, and the measures for protection and safety. This training should be adapted to the experiments and activities conducted and should be revised and repeated as often as necessary.
- (f) Arrangements for protection of the public. Such arrangements include the control of discharges of radioactive material to the environment, management of radioactive waste, and demonstration of compliance with dose limits and constraints for public exposure.
- (g) Arrangements for the prevention of accidents and mitigation of their consequences and for emergency preparedness and response.
- (h) Arrangements for periodically reviewing and auditing the performance of the radiation protection programme and for implementing improvements where appropriate.

The key points should be summarized on a leaflet given to workers and students who might be exposed to radiation sources and should be prominently displayed at important locations.

4.22. The elements of the radiation protection programme should be documented appropriately, taking into account the scale and complexity of operations. The radiation protection programme should include a commitment by the management to keep radiation doses as low as reasonably achievable and to foster a positive safety culture (see Requirements 2 and 12 of GSR Part 2 [29]).