

IAEA Safety Standards

for protecting people and the environment

Classification of Radioactive Waste

General Safety Guide No. GSG-1



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CLASSIFICATION OF RADIOACTIVE WASTE

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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. GSG-1

CLASSIFICATION OF RADIOACTIVE WASTE

GENERAL SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2009

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FOREWORD

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

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

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

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

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

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. The safety requirements use 'shall' statements together with statements of

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

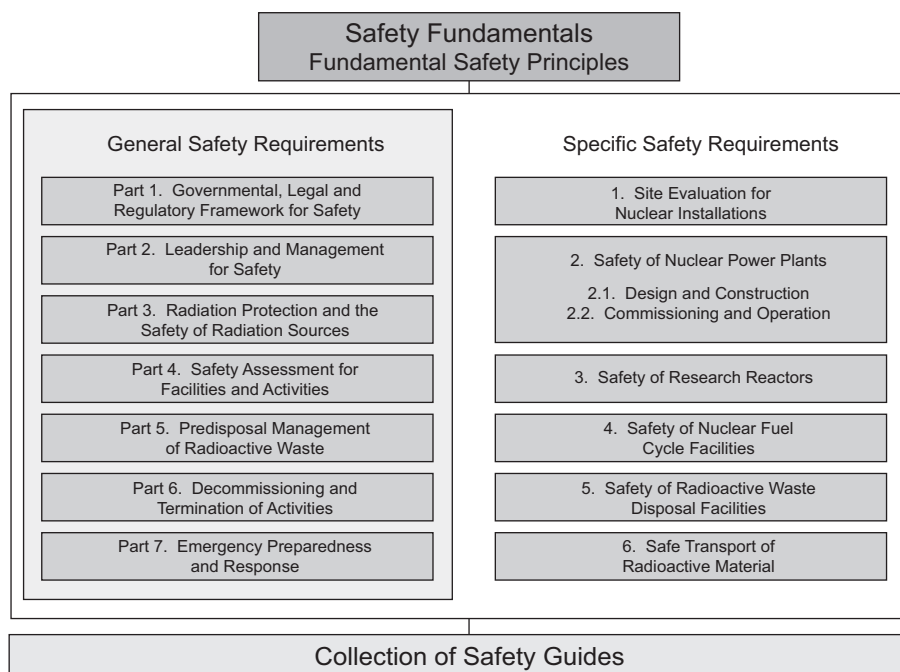


FIG. 1. The long term structure of the IAEA Safety Standards Series.

associated conditions to be met. 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 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 four safety standards committees, for 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).

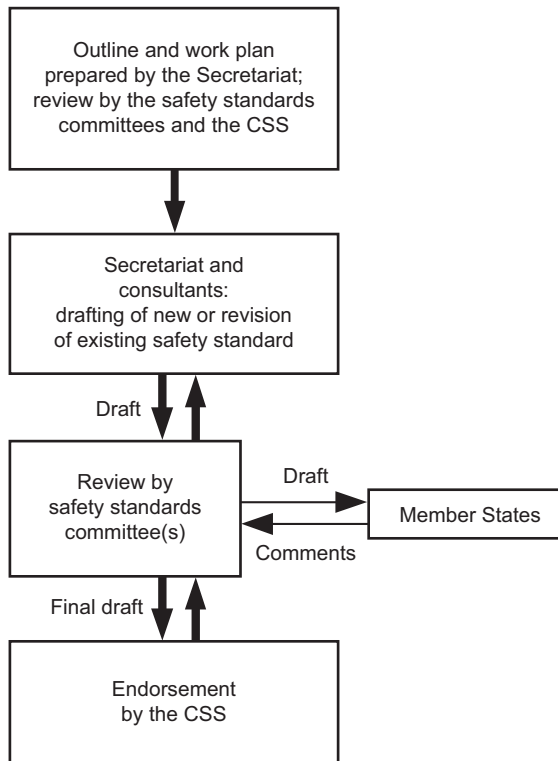


FIG. 2. The process for developing a new safety standard or revising an existing standard.

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. 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 Safety Glossary (see <http://www-ns.iaea.org/standards/safety-glossary.htm>). 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.

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1. INTRODUCTION

BACKGROUND

1.1. Radioactive waste is generated in a number of different kinds of facilities and it may arise in a wide range of concentrations of radionuclides and in a variety of physical and chemical forms. These differences result in an equally wide variety of options for the management of the waste. There is a variety of alternatives for processing waste and for short term or long term storage prior to disposal. Likewise, there are various alternatives for the safe disposal of waste, ranging from near surface to geological disposal.

1.2. The Safety Requirements publication, *Predisposal Management of Radioactive Waste* [1], requires that: “At various steps in the predisposal management of radioactive waste, the radioactive waste shall be characterized and classified in accordance with requirements established or approved by the regulatory body” (Requirement 9). This is to ensure that proper and adequate provision is made for the safety implications associated with the management and disposal of the waste.

1.3. Various schemes have evolved for classifying radioactive waste according to the physical, chemical and radiological properties that are of relevance to particular facilities or circumstances in which radioactive waste is managed. These schemes have led to a variety of terminologies, which may differ from State to State and even between facilities in the same State. In some instances, this has given rise to difficulties in establishing consistent and coherent national waste management policies and implementing strategies, and can lead to less than optimal levels of safety. It also makes communication on waste management practices difficult nationally and internationally, particularly in the context of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [2]. Comparison of data published in the scientific literature is not straightforward, and difficulties can arise in trying to understand waste management programmes and practices both within and between States.

1.4. In order to address these issues, the classification of radioactive waste has been the subject of international standards on the safety of radioactive waste management. The first standard on the subject was published in 1970¹, and revisions were published in 1981² and 1994³. An explanation of the evolution of these standards is presented in Annex I. The classification scheme presented in this Safety Guide supersedes the classification schemes in the earlier standards.

1.5. Different types of waste may be grouped for operational waste management purposes. For example, waste containing radionuclides with short half-lives may be separated from waste containing radionuclides with longer half-lives, or compressible waste may be separated from non-compressible waste. The topic of operational waste management is addressed in Ref. [3]. Nevertheless, apart from waste containing only short lived radionuclides, all other types of radioactive waste need to be eventually disposed of in a manner consistent with the Fundamental Safety Principles [4] and with safety requirements for the management of radioactive waste and for the disposal of radioactive waste.

1.6. The classification scheme developed previously³ is not completely comprehensive in that it does not cover all types of radioactive waste, nor does it provide a direct linkage with disposal options for all types of radioactive waste. These aspects of the former classification scheme have been deemed limitations on its use and application.

1.7. The generic linkage between the different classes of waste and disposal options is addressed in this Safety Guide but, notwithstanding such generic linkage, the suitability of waste for disposal in a particular disposal facility is required to be demonstrated by the safety case and supporting safety assessment for the facility [5].

¹ INTERNATIONAL ATOMIC ENERGY AGENCY, Standardization of Radioactive Waste Categories, Technical Reports Series No. 101, IAEA, Vienna (1970).

² INTERNATIONAL ATOMIC ENERGY AGENCY, Underground Disposal of Radioactive Waste: Basic Guidance, Safety Series No. 54, IAEA, Vienna (1981).

³ INTERNATIONAL ATOMIC ENERGY AGENCY, Classification of Radioactive Waste, Safety Series No. 111-G-1.1, IAEA, Vienna (1994).

OBJECTIVE

1.8. The objective of this Safety Guide is to set out a general scheme for classifying radioactive waste that is based primarily on considerations of long term safety, and thus, by implication, disposal of the waste. This Safety Guide, together with other IAEA safety standards on radioactive waste, will assist in the development and implementation of appropriate waste management strategies and will facilitate communication and information exchange within and among States. Disposal is considered the final step in the management of radioactive waste, as stipulated in Safety Requirements publications on predisposal management of radioactive waste and disposal of radioactive waste [1, 5].

1.9. The Safety Guide identifies the conceptual boundaries between different classes of waste and provides guidance on their definition on the basis of long term safety considerations. While the usefulness is recognized of classification schemes for the safe operational management of radioactive waste, including the transport of waste, such schemes are subject to different considerations and are not addressed in this Safety Guide.

SCOPE

1.10. This Safety Guide provides guidance on the classification of the whole range of radioactive waste: from spent nuclear fuel, when it is considered radioactive waste, to waste having such low levels of activity concentration that it is not required to be managed or regulated as radioactive waste. This Safety Guide covers disused sealed sources, when they are considered waste, and waste containing radionuclides of natural origin. The recommendations in this Safety Guide are applicable to waste arising from all origins, including waste arising from facilities and activities, waste arising from existing situations and waste that may arise from accidents.

1.11. The classification scheme developed in this Safety Guide is focused on solid radioactive waste. However, the fundamental approach could also be applicable to the management of liquid and gaseous waste, with appropriate consideration given to aspects including the processing of such waste to produce a solid waste form that is suitable for disposal.

1.12. The Safety Guide does not give consideration to non-radioactive hazardous constituents of radioactive waste if they do not affect radiation

safety. It will be necessary to take into consideration the non-radiological hazard associated with such constituents in accordance with national requirements, but this is outside the scope of this Safety Guide. In some States such waste is sometimes referred to as ‘mixed waste’.

1.13. It is important that the characteristics of any particular radioactive waste be known for decisions to be made on its processing, storage and disposal; however, approaches to and methods for the characterization of radioactive waste are not addressed in this Safety Guide.

STRUCTURE

1.14. This Safety Guide consists of two sections, an appendix and three annexes. The scheme for classification of radioactive waste is set out in Section 2. The Appendix expands on the general scope and objectives of classification schemes for radioactive waste. It discusses the purpose and limitations of the classification scheme described in this Safety Guide, and explains the approach adopted in the development of the scheme for classification of radioactive waste. The Appendix also discusses the criteria and waste management activities considered in the determination of waste classes. Annex I describes the evolution of the IAEA safety standards on classification of radioactive waste. Annex II discusses the various purposes of and approaches to waste classification as well as qualitative and quantitative methods for waste classification. Annex III describes various types of radioactive waste and illustrates the application of the waste classification scheme developed in this Safety Guide to these types of radioactive waste.

2. THE RADIOACTIVE WASTE CLASSIFICATION SCHEME

OVERVIEW

2.1. A number of elements of the classification scheme previously set out³ have been retained. However, the scheme has been modified to address the shortcomings identified with the previous scheme (see para. 1.6) and to reflect experience gained in developing, operating and assessing the safety of disposal

facilities. A comprehensive range of waste classes has been defined and general boundary conditions between the classes are provided. More detailed quantitative boundaries that take into account a broader range of parameters may be developed in accordance with national programmes and requirements. In cases when there is more than one disposal facility in a State, the quantitative boundaries between the classes for different disposal facilities may differ in accordance with scenarios, geological and technical parameters and other parameters that are relevant to the site specific safety assessment.

2.2. In accordance with the approach outlined in the Appendix, six classes of waste are derived and used as the basis for the classification scheme:

- (1) Exempt waste⁴ (EW): Waste that meets the criteria for clearance, exemption or exclusion from regulatory control for radiation protection purposes as described in Ref. [6].
- (2) Very short lived waste (VSLW): Waste that can be stored for decay over a limited period of up to a few years and subsequently cleared from regulatory control according to arrangements approved by the regulatory body, for uncontrolled disposal, use or discharge. This class includes waste containing primarily radionuclides with very short half-lives often used for research and medical purposes.
- (3) Very low level waste (VLLW): Waste that does not necessarily meet the criteria of EW, but that does not need a high level of containment and isolation and, therefore, is suitable for disposal in near surface landfill type facilities with limited regulatory control. Such landfill type facilities may also contain other hazardous waste. Typical waste in this class includes soil and rubble with low levels of activity concentration. Concentrations of longer lived radionuclides in VLLW are generally very limited.
- (4) Low level waste (LLW): Waste that is above clearance levels, but with limited amounts of long lived radionuclides. Such waste requires robust isolation and containment for periods of up to a few hundred years and is suitable for disposal in engineered near surface facilities. This class covers a very broad range of waste. LLW may include short lived radionuclides at higher levels of activity concentration, and also long lived radionuclides, but only at relatively low levels of activity concentration.

⁴ The term 'exempt waste' has been retained from the previous classification scheme (see footnote 3) for consistency; however, once such waste has been cleared from regulatory control, it is not considered radioactive waste.