

IAEA SAFETY STANDARDS SERIES

Decommissioning of Nuclear Power Plants and Research Reactors

SAFETY GUIDE

No. WS-G-2.1



INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA

IAEA SAFETY RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

Under the terms of Article III of its Statute, the IAEA is authorized to establish standards of safety for protection against ionizing radiation and to provide for the application of these standards to peaceful nuclear activities.

The regulatory related publications by means of which the IAEA establishes safety standards and measures are issued in the **IAEA Safety Standards Series**. This series covers nuclear safety, radiation safety, transport safety and waste safety, and also general safety (that is, of relevance in two or more of the four areas), and the categories within it are **Safety Fundamentals**, **Safety Requirements** and **Safety Guides**.

Safety Fundamentals (blue lettering) present basic objectives, concepts and principles of safety and protection in the development and application of nuclear energy for peaceful purposes.

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Information on the IAEA's safety standards programme (including editions in languages other than English) is available at the IAEA Internet site

www.iaea.org/ns/coordinet

or on request to the Safety Co-ordination Section, IAEA, P.O. Box 100, A-1400 Vienna, Austria.

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This publication has been superseded by SSG-47.

DECOMMISSIONING OF NUCLEAR POWER PLANTS AND RESEARCH REACTORS

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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".

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FOREWORD

by Mohamed ElBaradei
Director General

One of the statutory functions of the IAEA is to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes, and to provide for the application of these standards to its own operations as well as to assisted operations and, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of nuclear energy.

The following advisory bodies oversee the development of safety standards: the Advisory Commission on Safety Standards (ACSS); the Nuclear Safety Standards Advisory Committee (NUSSAC); the Radiation Safety Standards Advisory Committee (RASSAC); the Transport Safety Standards Advisory Committee (TRANSSAC); and the Waste Safety Standards Advisory Committee (WASSAC). Member States are widely represented on these committees.

In order to ensure the broadest international consensus, safety standards are also submitted to all Member States for comment before approval by the IAEA Board of Governors (for Safety Fundamentals and Safety Requirements) or, on behalf of the Director General, by the Publications Committee (for Safety Guides).

The IAEA's safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA. Any State wishing to enter into an agreement with the IAEA for its assistance in connection with the siting, design, construction, commissioning, operation or decommissioning of a nuclear facility or any other activities will be required to follow those parts of the safety standards that pertain to the activities to be covered by the agreement. However, it should be recalled that the final decisions and legal responsibilities in any licensing procedures rest with the States.

Although the safety standards establish an essential basis for safety, the incorporation of more detailed requirements, in accordance with national practice, may also be necessary. Moreover, there will generally be special aspects that need to be assessed by experts on a case by case basis.

The physical protection of fissile and radioactive materials and of nuclear power plants as a whole is mentioned where appropriate but is not treated in detail; obligations of States in this respect should be addressed on the basis of the relevant instruments and publications developed under the auspices of the IAEA. Non-

radiological aspects of industrial safety and environmental protection are also not explicitly considered; it is recognized that States should fulfil their international undertakings and obligations in relation to these.

The requirements and recommendations set forth in the IAEA safety standards might not be fully satisfied by some facilities built to earlier standards. Decisions on the way in which the safety standards are applied to such facilities will be taken by individual States.

The attention of States is drawn to the fact that the safety standards of the IAEA, while not legally binding, are developed with the aim of ensuring that the peaceful uses of nuclear energy and of radioactive materials are undertaken in a manner that enables States to meet their obligations under generally accepted principles of international law and rules such as those relating to environmental protection. According to one such general principle, the territory of a State must not be used in such a way as to cause damage in another State. States thus have an obligation of diligence and standard of care.

Civil nuclear activities conducted within the jurisdiction of States are, as any other activities, subject to obligations to which States may subscribe under international conventions, in addition to generally accepted principles of international law. States are expected to adopt within their national legal systems such legislation (including regulations) and other standards and measures as may be necessary to fulfil all of their international obligations effectively.

PREFACE

Radioactive waste is produced in the generation of nuclear power and the use of radioactive materials in industry, research and medicine. The importance of the safe management of radioactive waste for the protection of human health and the environment has long been recognized, and considerable experience has been gained in this field.

The IAEA's Radioactive Waste Safety Standards Programme aimed at establishing a coherent and comprehensive set of principles and requirements for the safe management of waste and formulating the guidelines necessary for their application. This is accomplished within the IAEA Safety Standards Series in an internally consistent set of publications that reflect an international consensus. The publications will provide Member States with a comprehensive series of internationally agreed publications to assist in the derivation of, and to complement, national criteria, standards and practices.

The Safety Standards Series consists of three categories of publications: Safety Fundamentals, Safety Requirements and Safety Guides. With respect to the Radioactive Waste Safety Standards Programme, the set of publications is currently undergoing review to ensure a harmonized approach throughout the Safety Standards Series.

This Safety Guide addresses the subject of decommissioning of nuclear power plants and research reactors. It is intended to provide guidance to national authorities and operating organizations for the planning and safe management of the decommissioning of such installations.

This Safety Guide has been prepared through a series of Consultants and Technical Committee meetings. It supersedes former Safety Series publications Nos 52, 74 and 105.

EDITORIAL NOTE

An appendix, when included, is considered to form an integral part of the standard and to have the same status as the main text. Annexes, footnotes and bibliographies, if included, are used to provide additional information or practical examples that might be helpful to the user.

The safety standards use the form 'shall' in making statements about requirements, responsibilities and obligations. Use of the form 'should' denotes recommendations of a desired option.

The English version of the text is the authoritative version.

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1. INTRODUCTION

BACKGROUND

1.1. This Safety Guide is part of a set of publications within the framework of the IAEA Radioactive Waste Safety Standards Programme, which addresses all the important areas of radioactive waste safety. This set includes Safety Fundamentals [1], Safety Requirements and Safety Guides in the old IAEA Safety Series and IAEA Safety Standards Series.

1.2. Safety requirements for the decommissioning of nuclear power plants and research reactor facilities are addressed in the Safety Requirements: Predisposal Management of Radioactive Waste Including Decommissioning [2]. Other IAEA Safety Standards provide additional relevant safety requirements [3–9].

1.3. A large number of ageing reactors will be facing shutdown in the near future. In the past, decommissioning of nuclear power plants and research reactors was performed in a case by case manner using the same framework of regulations as applied during the operational period of a reactor. In order to provide a consistent and harmonious approach to the decommissioning of nuclear reactor installations, as well as to incorporate lessons learned from previous decommissioning efforts, Member States have expressed the need for decommissioning guidance within the context of an internationally accepted programme of radioactive waste safety publications.

1.4. This Safety Guide provides recommendations, on the basis of international experience, to assist in fulfilling the basic requirements for decommissioning as set out in the above mentioned Safety Requirements [2].

OBJECTIVE

1.5. The objective of this Safety Guide is to provide guidance to national authorities, including regulatory bodies, and operating organizations to ensure that the decommissioning process for nuclear power plants and research reactors is conducted in a safe and environmentally acceptable manner.

SCOPE

1.6. The provisions of this Safety Guide apply to nuclear power plants and research reactors and their associated sites. A separate Safety Guide addresses the decommissioning of medical, industrial and research facilities [10].

1.7. This Safety Guide mainly addresses the radiological hazards resulting from the activities associated with the decommissioning of nuclear reactors, primarily with decommissioning after planned final shutdown. Many of the provisions are also applicable to decommissioning after an abnormal event that has resulted in serious plant damage or contamination. In this case, this Safety Guide may be used as a basis for developing special decommissioning provisions, although additional considerations will be necessary.

1.8. Non-radiological hazards, such as those due to potential fire sources or those resulting from the release of asbestos material, can also arise during decommissioning activities. This Safety Guide does not explicitly address these hazards, but it is important that they be given due consideration during the planning process and in a risk analysis.

STRUCTURE

1.9. Issues that are essential to the decommissioning of nuclear power plants and research reactors are outlined in Section 2. The process for selecting the proper decommissioning option is discussed in Section 3. The considerations at the design, construction and operational phases of the installation lifetime which facilitate decommissioning are reviewed in Section 4. Decommissioning planning, safety assessment and financial assurance are addressed in Section 5. Tasks which are critical to decommissioning because of their complexity and/or their relevance to key safety issues are explained in Section 6. The overall management of the decommissioning process is detailed in Section 7. Completion of decommissioning and the contents of the final decommissioning report are discussed in Section 8.

1.10. Annex I provides an example of the contents of a final radiological survey report. Annex II presents an example of documented plans and management systems for the implementation of decommissioning.

2. KEY ISSUES SPECIFIC TO DECOMMISSIONING

GENERAL

2.1. The term decommissioning refers to administrative and technical actions taken to allow removal of some or all of the regulatory controls from a nuclear facility (except for a repository, which is, by definition, subject to closure and not decommissioning). These actions involve decontamination, dismantling and removal of radioactive materials, waste, components and structures. They are carried out to achieve a progressive and systematic reduction in radiological hazards and are taken on the basis of preplanning and assessment to ensure safety during decommissioning operations.

2.2. The time period to the decommissioning activities for nuclear power plants and research reactors may typically range from a few years to decades (for example, to allow for radioactive decay). As a consequence, decommissioning may be carried out in one continuous operation following shutdown or in a series of discrete operations over time (i.e. phased decommissioning).

2.3. Decommissioning may include the phased release of parts of the nuclear installation or of the site from regulatory control, before the decommissioning process for the entire installation or site is complete. In the event that a part of the installation is being decommissioned, this Safety Guide only applies to the decommissioning activities. However, the potential safety implications with respect to the interaction between any decommissioning work and any continuing nuclear installation operations need to be addressed on a case by case basis.

2.4. Subject to national legal and regulatory requirements, a nuclear installation or its remaining parts may also be considered decommissioned if incorporated into a new or existing facility, or even if the site at which it is located is still under regulatory or other institutional control. This could apply, for example, to the decommissioning of a nuclear installation located on a multifacility site.

2.5. There are many factors that have to be addressed to ensure the safety of nuclear reactors during the operational phase. Some of the factors will continue to apply during decommissioning, but decommissioning gives rise to issues that are in some respects different from those prevailing during the operation of the installation. These issues need to be considered in an appropriate way to ensure overall safety during decommissioning.

RESPONSIBILITIES

2.6. When a nuclear reactor is taken out of service, responsibility for the installation may be transferred to a different organization, which becomes the operating organization of the installation for the decommissioning phase. The operating organization of the installation undergoing decommissioning is ultimately responsible for the safety of the installation during the decommissioning operations. For such transference to be effective, a complete set of records and drawings should be maintained and passed on to the new operating organization. Decommissioning activities may involve many different organizations, including contractors and subcontractors which may not be familiar with nuclear installations, and it is of prime importance to define clearly the responsibilities between the different organizations.

2.7. The operating organization should develop a public information programme to provide information on the decommissioning project.

REGULATORY FRAMEWORK

2.8. The regulatory framework of a country should include provision for the decommissioning of nuclear installations, in particular nuclear reactors. National regulatory authorities should provide guidance on radiological criteria for the removal of regulatory controls over the decommissioned installations and sites and should ensure that an adequate system is in place for properly managing the removal of controls.

2.9. Some activities relevant to decommissioning may be carried out after shutdown of the nuclear installation under licence provisions carried over from the operating phase. Such activities may include management of operational waste, measurements to determine the radioactive inventory, removal from the installation of nuclear fuel or other materials related to the original operation, and preliminary decontamination.

2.10. In the absence of regulations addressing decommissioning, decommissioning activities should be undertaken on a case by case basis under existing regulations for operational installations. In such cases, the operating organization should consult the regulatory body in the development and implementation of the decommissioning plan. In the plan, the operating organization should be required to demonstrate how compliance with the regulations will be achieved.

2.11. The regulatory control of decommissioning can be done by a single overall licence, by separate licences, or by direct control by a regulatory body, whichever is