



IAEA

60 Years

Atoms for Peace and Development

Regional Workshop on the Development of National Strategies and Regulatory Requirements for Spent Fuel Management

IAEA Safety Standards

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Division of Radiation,

Transport and Waste Safety

IAEA

Asian Nuclear Safety Network (ANSN)
Nuclear and Radiation Safety Center
Beijing, China. 11 - 15 September 2023



IAEA

60 Years

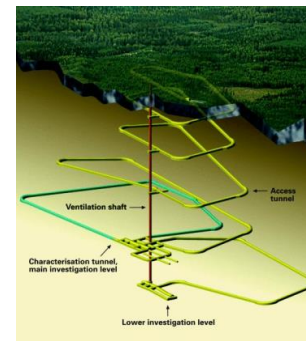
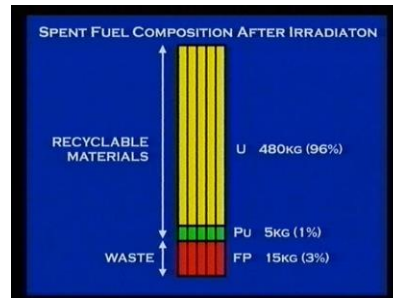
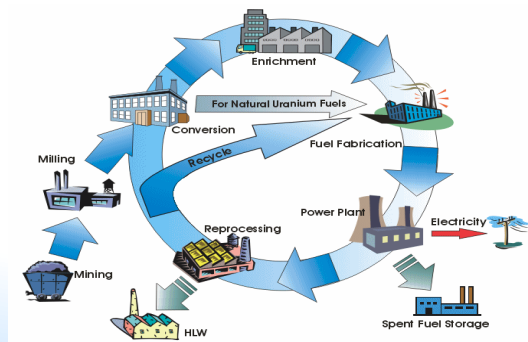
Atoms for Peace and Development

Contents

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 - Safety Fundamentals
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 - Safety Guides
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 - Disposal of Radioactive Waste
- **Other Relevant IAEA Publications**

Spent Fuel: Waste or Resource?

- The definition of a fuel cycle policy rests with the State
 - Spent fuel can be considered as a resource that may be reprocessed, while other States elect to dispose of it
 - Whatever option is chosen, the disposal of high-level waste (HLW), separated at reprocessing, or of spent fuel regarded as waste should be considered.

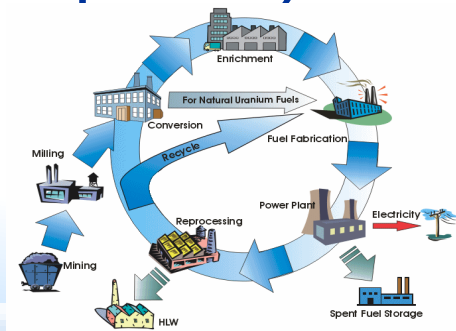


Selection of Management Options

- Spent fuel management has proven to be the most complex decision for RW
- Several Considerations:
 - Protection of Health and Environment
 - Amount of Spent Fuel; Storage capacity
 - Safety Considerations related to LTS (e.g., cladding)
 - Technical Infrastructure & Financial Resources Available
 - Public Consultation
 - Social and Political Conditions

Spent Fuel Management Options

- Two main alternatives
 - Reprocessing (France, UK, Russia, etc)
 - Direct disposal (Sweden, Finland, USA, etc)
 - Spent fuel may also be stored for use at a later date (not considered a waste)
- All predisposal options involve a period of storage of the spent fuel (about 3-5 years in NPP fuel ponds)



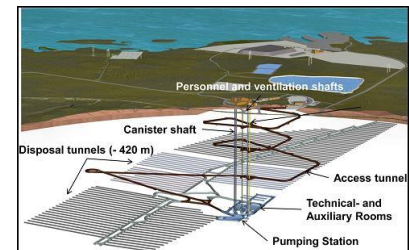
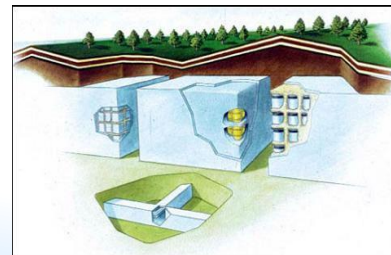
Storage

- Defined as the holding of spent fuel or RW in a facility that provides for their/its containment, with the intention of retrieval.
- Intermediate step requiring retrieval for later re-use or disposal
- Time scales are at most a few tens of years.
- Storage of spent fuel and RW, including LTS, is an interim solution, not an alternative to disposal.
- In the longer term, *only disposal with its inherent passive safety* can guarantee protection against all potential hazards.

need for inspection, retrievability



passive safety



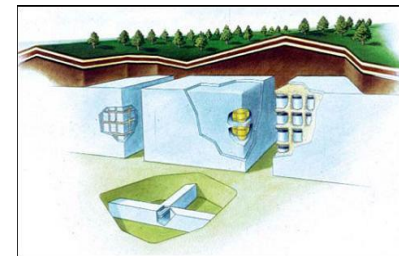
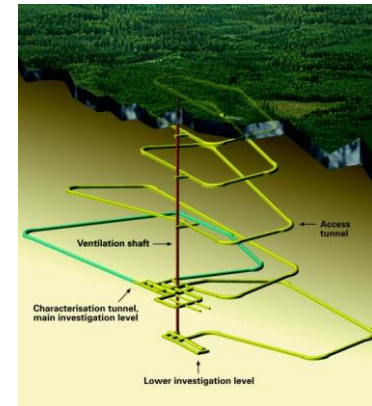
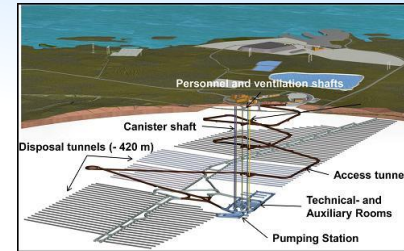


Long Term Storage Challenges

- Safety of Long Term (100 yr) Storage Periods
 - Need for better waste packages
 - Fuel, container and concrete degradation
- Storage Capacity
 - Centralized Storage
- Possible need for specific fuel designs
- On-going needs for maintenance, record keeping and funding
- Societal and economic instability
- Public acceptance

Geological Disposal of HLW

- IAEA Safety Standards require safe management of spent fuel and HLW including their geological disposal
 - Includes HLW separated at reprocessing, or of spent fuel regarded as waste
 - Ensures responsible and safe management of SF and RW to avoid imposing undue burden on future generations
 - National arrangements for a high level of safety to protect workers and the general public against dangers arising from ionising radiation.



Geological Disposal: Challenges

- Experience shows that it takes decades to research, site, design, construct and operate and licence HLW disposal facilities and this suggests that work on disposal should begin at the start of a nuclear power programme.
- In some countries there seems to be a trend towards developing strategies of longer waste storage periods instead of developing and consequently implementing disposal programmes.

JOINT CONVENTION

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

CHAPTER 2 SAFETY OF SPENT FUEL MANAGEMENT

ARTICLE 4. GENERAL SAFETY REQUIREMENTS

- Each Contracting Party shall take the appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.
- In so doing, each Contracting Party shall take the appropriate steps to:
 - (i) ensure that criticality and removal of residual heat generated during spent fuel management are adequately addressed;
 - (ii) ensure that the generation of radioactive waste associated with spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;
 - (iii) take into account interdependencies among the different steps in spent fuel management;
 - (iv) provide for effective protection of individuals, society and the environment, by applying at the national level suitable protective methods as approved by the regulatory body, in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;
 - (v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;
 - (vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;
 - (vii) aim to avoid imposing undue burdens on future generations.

JOINT CONVENTION

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

CHAPTER 2 SAFETY OF SPENT FUEL MANAGEMENT

ARTICLE 10. DISPOSAL OF SPENT FUEL

If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.

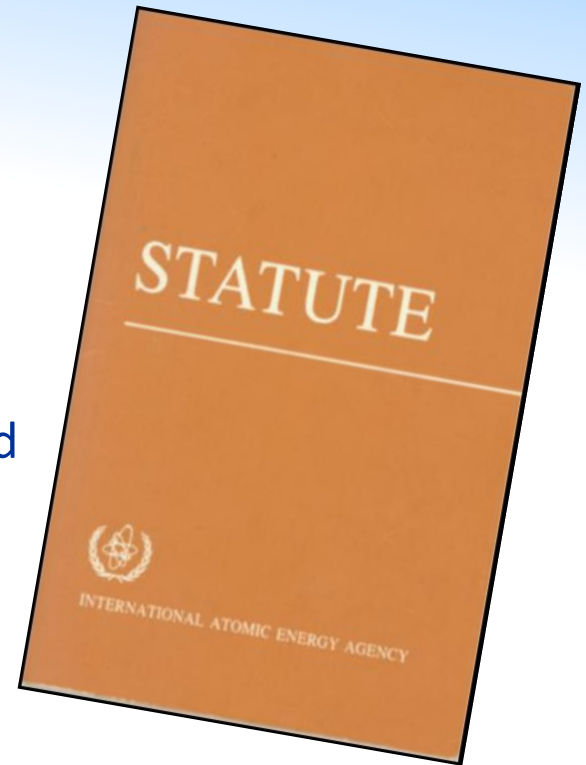
IAEA Statutory Obligations (1957)

Article III, *Functions* Paragraph A.6.

“ 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 (including such standards for labour conditions), and

to provide for the application of these standards to its own operation as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency ...; “



Status of Safety Standards

- IAEA Safety standards are
 - Binding for IAEA's own activities
 - Not binding on the Member States (but may be adopted by them) EXCEPT in relation to operations assisted by the IAEA e.g.:
 - Integrated Regulatory Review Service
 - Technical Cooperation Fund work
 - States wishing to enter into project agreements with the IAEA

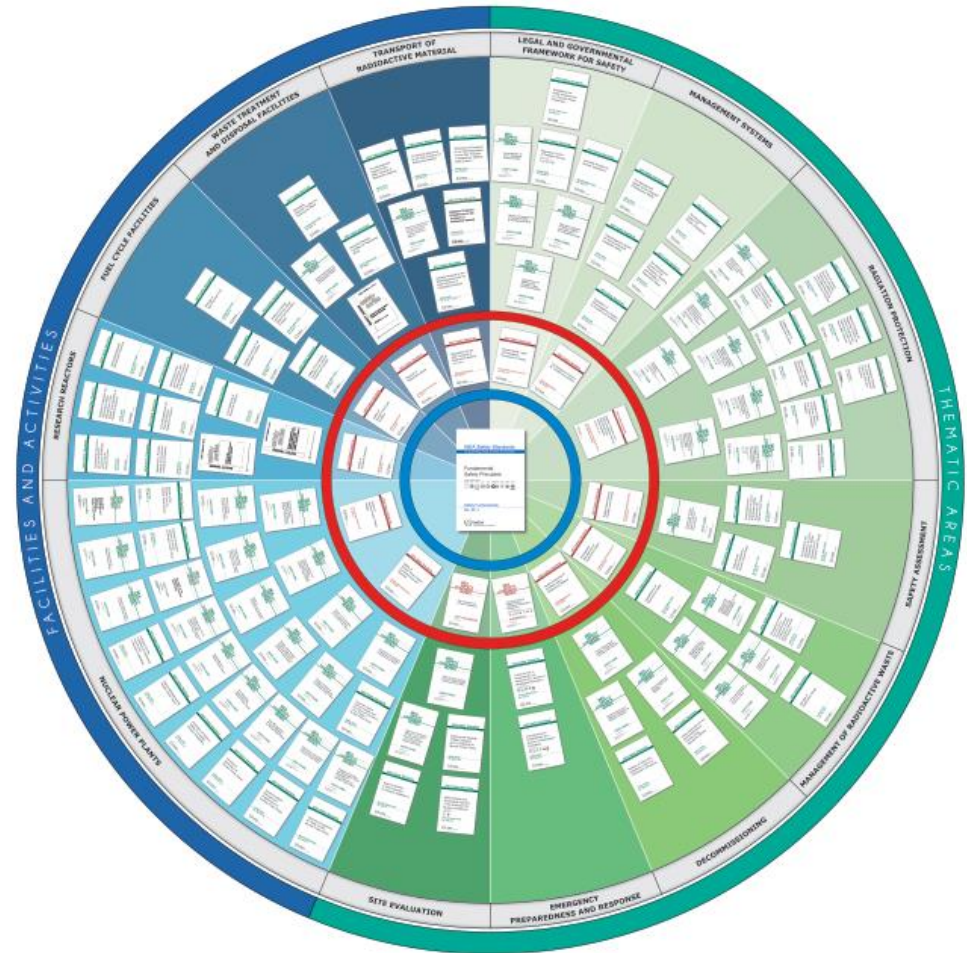
<http://www-ns.iaea.org/standards/default.asp>

The “wheel” of IAEA safety standards

- The SS are issued under the authority of the IAEA Board of Governors. The authority to issue Safety Guides has been delegated by the BoG to the IAEA Director General. *The SS are the only Agency publications approved by the IAEA Board of Governors.*
- The series is maintained at a manageable size, about 130 to 140 standards.
- Need for revision of **Safety Requirements** evaluated every 10 years.
- Need for revision of **Safety Guides** evaluated every 5 years.

Applicable, as relevant, throughout the entire lifetime of facilities and activities — existing and new — utilized for peaceful purposes

IAEA Safety Standards protecting people and the environment



Status as of June 2012



IAEA
International Atomic Energy Agency
Atoms for Peace



The International Atomic Energy Agency (IAEA) is a United Nations system organization with its headquarters in Vienna, Austria. The IAEA's mission is to promote the peaceful use of nuclear energy and to prevent nuclear weapons proliferation. The IAEA's work is carried out through its various programmes and projects, which are supported by its Member States.

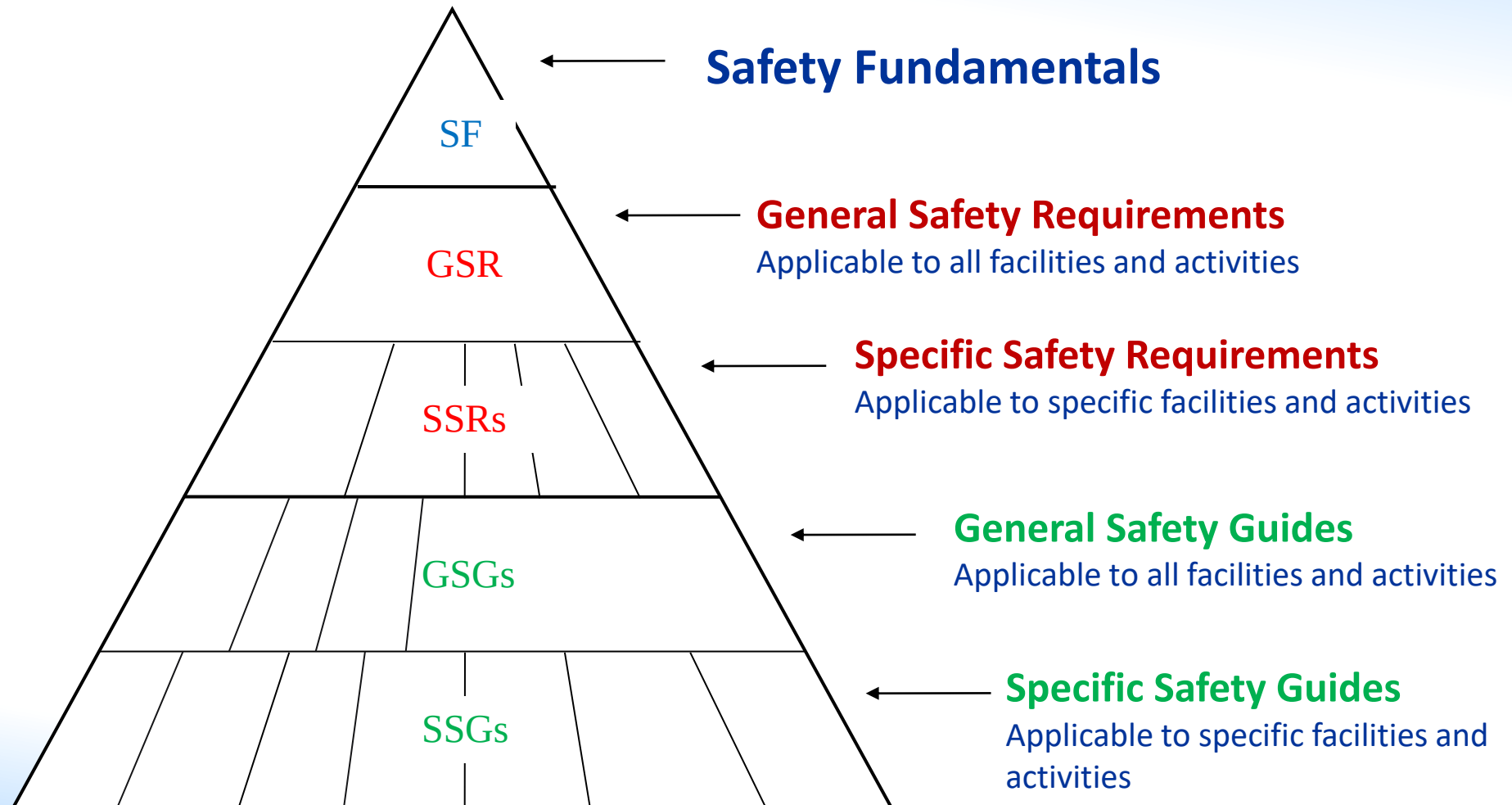
Further information on the activities undertaken by the IAEA can be found at: www.iaea.org

To provide high levels of nuclear safety, the IAEA publishes Safety Standards for use in the nuclear industry. The hierarchy of the Safety Standards begins with the Fundamental Safety Principles, then the Safety Requirements and finally the Safety Guides. In addition, numerous more specific technical reports are produced to support the Safety Standards. The Safety Standards are produced with the involvement and agreement of all Member States and provide a global reference for nuclear safety. All nuclear organizations in all Member States are encouraged to adopt and implement the principles, requirements and guidelines given in the Safety Standards in order to maintain and improve global nuclear safety.

The Safety Standards can be downloaded or ordered from www.iaea.org/safety, under 'List of all valid Safety Standards'.

Note: The grouping of Safety Standards into the 'nuclear' and 'non-nuclear' and 'safety' and 'security' areas is the subject of ongoing discussion by the membership of the IAEA and is subject to change. The IAEA's work is carried out through its various programmes and projects, which are supported by its Member States. The IAEA's work is carried out through its various programmes and projects, which are supported by its Member States. The IAEA's work is carried out through its various programmes and projects, which are supported by its Member States.

Safety Standards Hierarchy



Safety fundamentals

- **Policy document of the IAEA Safety Standards Series:**

States the basic objectives, concepts and principles involved in ensuring protection and safety



- **1 Objective**
- **10 safety principles**

- Responsibility for safety
- Role of government
- Leadership and management for safety
- Justification of facilities and activities
- Optimisation of protection
- Limitation of risks to individuals
- Protection of present and future generations.

People and the environment, present and future, must be protected against radiation risks

- Prevention of accidents
- Emergency preparedness and response
- Protective actions to reduce existing or unregulated radiation risks

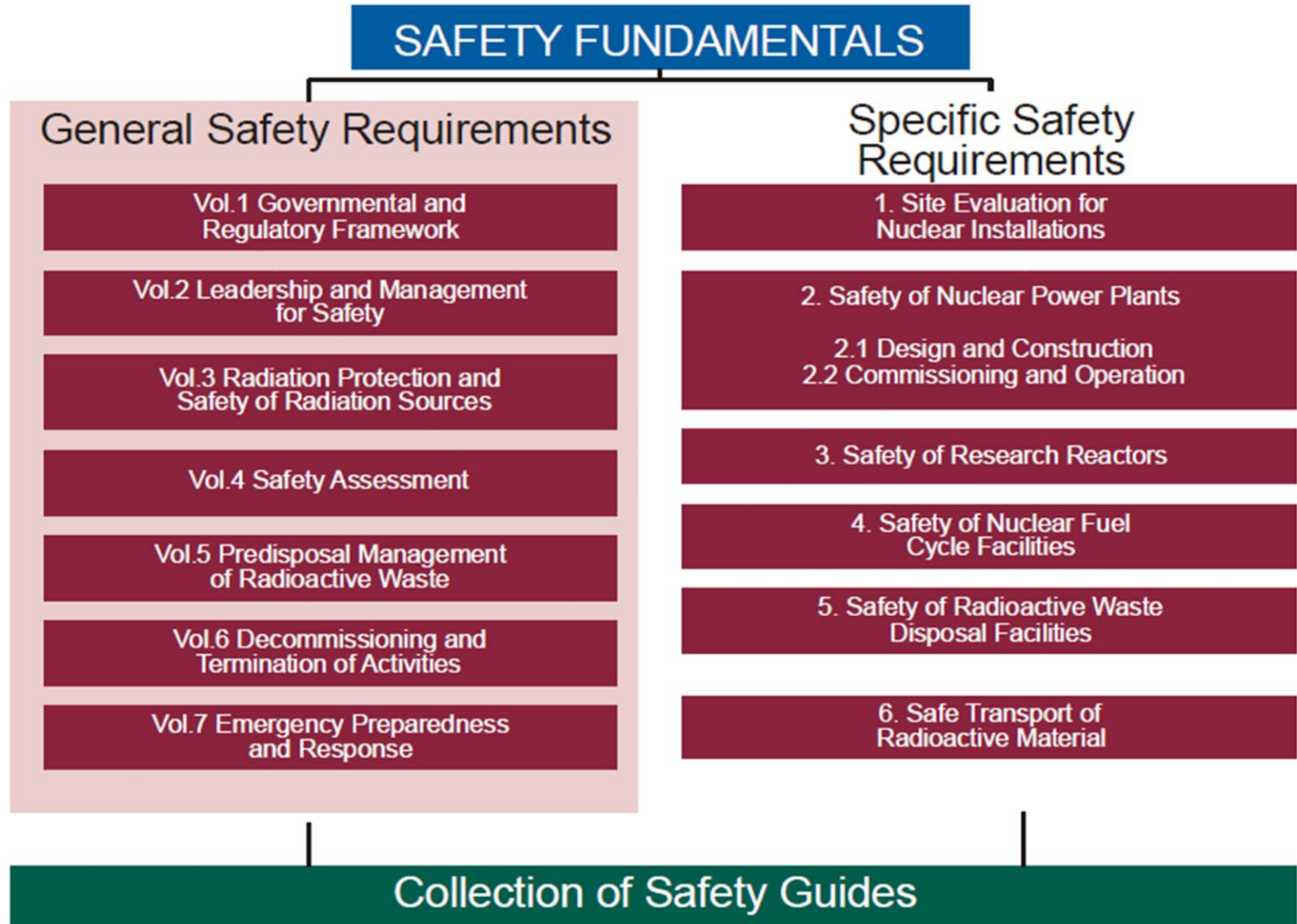
Safety Requirements

- Elaborate on the basic objectives and concepts of SF-1 as they apply to all or to specific activity or facility
- Should be concise and reflect the ‘What’ and ‘Who’ of safety management – associated explanatory text should describe ‘Why’ the requirements exist
- Requirements are expressed as ‘shall’ statements



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

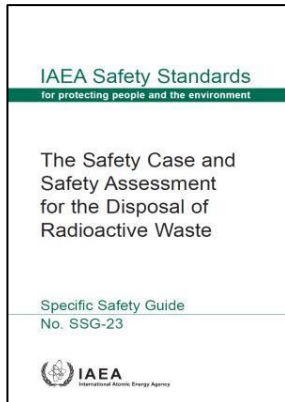
Safety Requirements



Safety Guides



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 to help users striving to achieve high levels of safety

The recommendations provided in Safety Guides are expressed as 'should' statements.

Safety Standards: Predisposal



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IAEA Atoms for Peace and Development

Safety Case & Safety Assessment

IAEA Safety Standards
for protecting people and the environment

Safety Assessment for
Facilities and Activities

General Safety Requirements Part
No. GSR Part 4



IAEA Safety Standards
for protecting people and the environment

Predisposal
Management of
Radioactive Waste

DS 548

General Safety Requirements Part 5
No. GSR Part 5



IAEA Safety Standards
for protecting people and the environment

Safety of Nuclear Fuel
Cycle Facilities

Specific Safety Requirements
No. SSR-4



EP&R

IAEA
SAFETY
STANDARDS
SERIES

Preparedness and
Response for a
Nuclear or Radiological
Emergency

JOINTLY SPONSORED BY
FAO, IAEA, ILO, OECD/NEA, PAHO, OCHA, WHO

REQUIREMENTS

No. GS-R-2



IAEA Safety Standards

for protecting people and the environment

Radiation Protection and
Safety of Radiation Sources:
International Basic
Safety Standards
INTERIM EDITION

General Safety Requirements Part 3
No. GSR Part 3 (Interim)

Radiation Protection

Management System

IAEA Safety Standards
for protecting people and the environment

Leadership and
Management for Safety

General Safety Requirements
No. GSR Part 2



IAEA Safety Standards
for protecting people and the environment

National Policies and Strategies
for the Safe Management of
Spent Fuel, Radioactive Waste,
and Residual Materials,
Decommissioning and
Remediation

DS 526

Safety Guide

No.



Storage

IAEA Safety Standards

for protecting people and the environment

The Safety Case and
Safety Assessment
for the Predisposal
Management of
Radioactive Waste

General Safety Guide
No. GSG-3

DS 553



IAEA Safety Standards

for protecting people and the environment

Safety of Nuclear Fuel
Cycle Research and
Development Facilities

Specific Safety Guide
No. SSG-43



IAEA Safety Standards

for protecting people and the environment

Predisposal Management
of Radioactive Waste
from Nuclear Fuel
Cycle Facilities

Specific Safety Guide
No. SSG-41



IAEA Safety Standards

for protecting people and the environment

Storage of
Radioactive Waste

DS 550

Safety Guide
No. WS-G-6.1



IAEA Safety Standards

for protecting people and the environment

Storage of
Spent Nuclear Fuel

Specific Safety Guide
No. SSG-15 (Rev. 1)



Management

IAEA Safety Standards

for protecting people and the environment

Leadership, Management
and Culture for Safety
in Radioactive Waste
Management

General Safety Guide
No. GSG-16



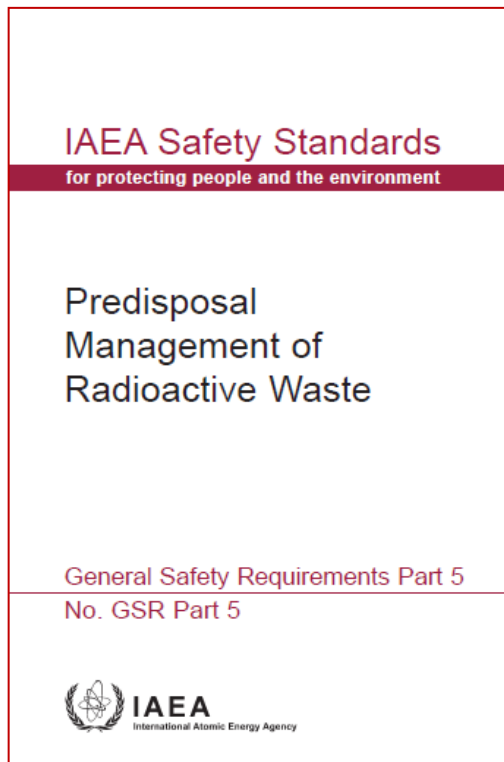
GSR Part 5: Predisposal Management of RW

OBJECTIVES

- To establish the requirements that must be satisfied in the predisposal management of RW
- To set out the objectives, criteria and requirements that apply to all stages of predisposal management facilities

SCOPE

- Predisposal management of all types of RW
- Predisposal management from generation up to disposal (incl. processing, storage, transport)



GSR Part 5 Predisposal Management of Radioactive Waste

- | | | |
|---|--|---|
| 1. Introduction | { | 1. Government responsibilities |
| 2. Protection of Human Health & Environment | | 2. National Policy & Strategy |
| 3. Responsibilities | | 3. Regulatory Responsibilities |
| 4. Steps in the Predisposal Management of RW | { | 4. Operator Responsibilities |
| 5. Development and Operation of RWM Facilities & Activities | | 5. Safety/Security |
| | | 6. Interdependences |
| | 7. Management systems | |
| | 8. Waste minimization | |
| | 9. Characterization and classification | |
| | { | 10. Waste treatment |
| | | 11. Waste storage |
| | | 12. Waste acceptance for processing, storage and/or disposal |
| | | 13. Prepare safety case and supporting safety assessment |
| | | 14. Safety case scope and regulatory compliance |
| | | 15. Safety case documentation |
| | | 16. Periodic safety review |
| | { | 17. Facilities location and design |
| | | 18. Facility construction and commissioning |
| | | 19. Facilities operation, maintenance, emergency preparedness |
| | | 20. Decommissioning |
| | | 21. Nuclear safeguards |
| | | 22. Existing facilities |

IAEA Safety Standards

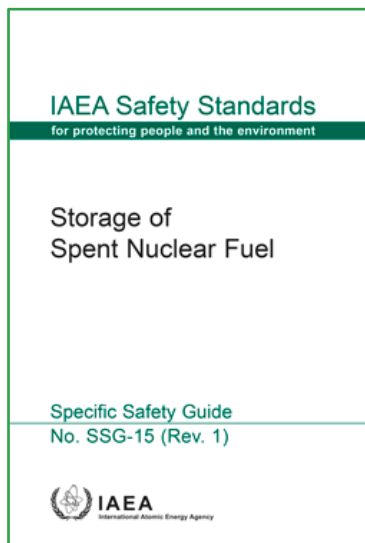
for protecting people and the environment

Predisposal
Management of
Radioactive Waste

General Safety Requirements Part 5

No. GSR Part 5

SSG-15: Storage of Spent Nuclear Fuel(1)



2020

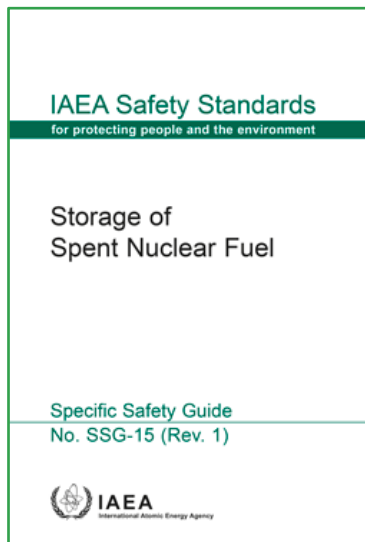
OBJECTIVE

- To provide recommendations on the design, commissioning, operation and assessment of safety for the different types of spent nuclear fuel storage *facility* (wet and dry), by considering different types of spent nuclear fuel from nuclear *reactors*, including research reactors, and different *storage* periods, including storage beyond the original design lifetime of the storage facility

SCOPE

- Spent nuclear fuel storage facilities that are either collocated with other nuclear facilities (e.g. nuclear power plant, research reactor, reprocessing plant) or located on their own site.
- NOT specifically intended to cover the storage of spent nuclear fuel as long as it remains a part of the operational activities of a nuclear reactor or a spent fuel reprocessing facility
- NOT provide comprehensive / detailed recommendations on physical protection

SSG-15: Storage of Spent Nuclear Fuel(2)



2020

1. INTRODUCTION
2. PROTECTION OF HUMAN HEALTH AND ENVIRONMENT
3. ROLES AND RESPONSIBILITIES
4. MANAGEMENT SYSTEM
5. SAFETY CASE AND SAFETY ASSESSMENT
6. GENERAL SAFETY CONSIDERATIONS FOR STORAGE OF SPENT NUCLEAR FUEL

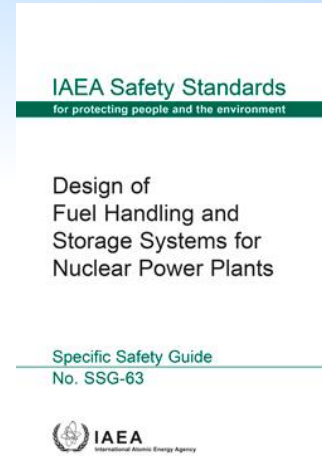
APPENIXES I & II

ANNEXES I-VI

SSG-63

Design of Fuel Handling and Storage Systems for Nuclear Power Plants

- The objective of this Safety Guide is to provide recommendations for the design of fuel handling and storage systems in nuclear power plants, in order to meet the requirements established in SSR-2/1 (Rev. 1) for these systems
- This Safety Guide addresses the design aspects of handling and storage systems for fuel that remains part of the operational activities of a nuclear reactor. From this perspective, this Safety Guide covers the following stages of fuel handling and storage in a nuclear power plant:
 - (a) Receipt of fresh fuel;
 - (b) Storage and inspection of fresh fuel before use;
 - (c) Transfer of fresh fuel into the reactor;
 - (d) Removal of irradiated fuel from the reactor and transfer of irradiated fuel to the spent fuel pool;
 - (e) Reinsertion of irradiated fuel from the spent fuel pool into the reactor, as necessary;
 - (f) Storage, inspection and repair of irradiated or spent fuel in the spent fuel pool, and the preparation for the removal of this fuel from the spent fuel pool;
 - (g) Handling of fuel casks in the spent fuel pool;
 - (h) Transfer of spent fuel casks.



Safety Standards: Disposal

IAEA Safety Standards for protecting people and the environment

Fundamental Safety Principles

Jointly sponsored by
Eurasian, IAEA, SLO, OECD/NEA, WHO, UNEP, WHO

Safety Fundamentals
No. SF-1



IAEA Safety Standards for protecting people and the environment

Leadership and Management for Safety

General Safety Requirements
No. GSR Part 2



IAEA Safety Standards for protecting people and the environment

Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards

Jointly sponsored by
EC, FAO, IAEA, SLO, OECD/NEA, WHO, UNEP, WHO

General Safety Requirements Part 3
No. GSR Part 3



IAEA Safety Standards for protecting people and the environment

Safety Assessment for Facilities and Activities

General Safety Requirements Part 4
No. GSR Part 4



IAEA Safety Standards for protecting people and the environment

Disposal of Radioactive Waste

Specific Safety Requirements
No. SSR-5



IAEA Safety Standards for protecting people and the environment

National Policies and Strategies for the Safe Management of Spent Fuel, Radioactive Waste, and Residual Materials, Decommissioning and Remediation

DS 526

Safety Guide
No.

IAEA Safety Standards for protecting people and the environment

Classification of Radioactive Waste

General Safety Guide
No. GSG-1



IAEA Safety Standards for protecting people and the environment

Near Surface Disposal Facilities for Radioactive Waste

Specific Safety Guide
No. SSG-29



IAEA Safety Standards for protecting people and the environment

Geological Disposal Facilities for Radioactive Waste

Specific Safety Guide
No. SSG-14



IAEA Safety Standards for protecting people and the environment

Preprint Borehole Disposal Facilities for Disused Sealed Radioactive Sources

To cite this preprint:
International Atomic Energy Agency, Borehole Disposal Facilities for Disused Sealed Radioactive Sources, IAEA Safety Standards Series No. SSG-17, IAEA, Vienna, 2023.

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IAEA Safety Standards for protecting people and the environment

The Safety Case and Safety Assessment for the Disposal of Radioactive Waste

Specific Safety Guide
No. SSG-23



IAEA Safety Standards for protecting people and the environment

Monitoring and Surveillance of Radioactive Waste Disposal Facilities

Specific Safety Guide
No. SSG-31



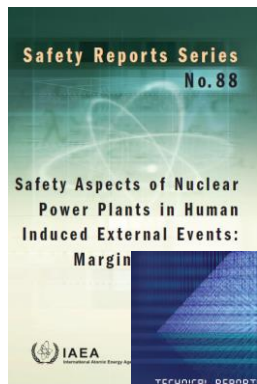
IAEA Safety Standards for protecting people and the environment

Leadership, Management and Culture for Safety in Radioactive Waste Management

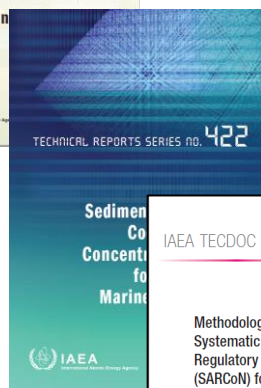
General Safety Guide
No. GSG-16



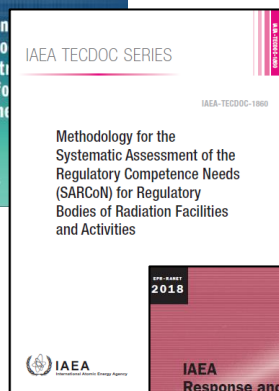
Informational publications



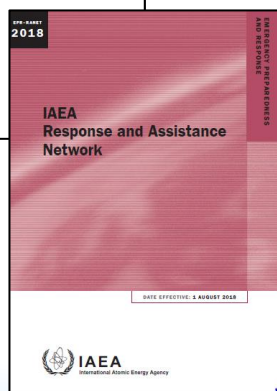
Safety Reports



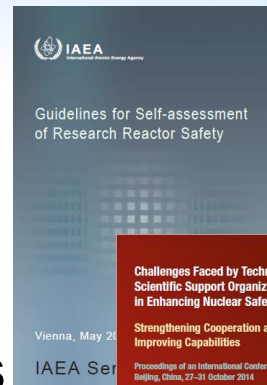
Technical Reports



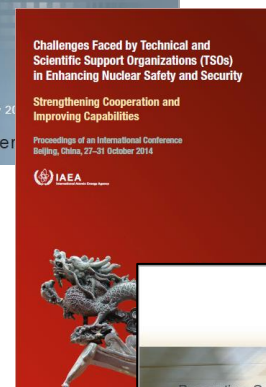
TECDOCs



EPR Series



Services Series



Proceedings Series



Non-serial publications

Informational publications

IAEA TECDOC SERIES



Some TECDOC publications

IAEA-TECDOC-1975

Spent Fuel Performance
Assessment and Research

*Final Report of a Coordinated Research
Project (SPAR-IV)*

IAEA-TECDOC-1862 Behaviour of Spent
Power Reactor Fuel During Storage

IAEA-TECDOC-1949 Phenomenology,
Simulation and Modelling of Accidents in
Spent Fuel Pools



IAEA-TECDOC-1975 Spent Fuel
Performance Assessment and Research

IAEA Nuclear Energy Series

- The publications in the IAEA Nuclear Energy Series (NES) provide information in the areas of nuclear power, nuclear fuel cycle, radioactive waste management and decommissioning, and on general issues that are relevant to all of the above mentioned areas.
- The structure of the IAEA Nuclear Energy Series comprises four levels:
 - Basic Principles
 - Objectives
 - Guides and Methodologies
 - Technical Reports
- The Nuclear Energy Basic Principles publication describes the rationale and vision for the peaceful uses of nuclear energy
- Nuclear Energy Series Objectives publications explain the expectations to be met in various areas at different stages of implementation
- Nuclear Energy Series Guides and Methodologies provide high level guidance or methods on how to achieve the objectives related to the various topics and areas involving the peaceful uses of nuclear energy.
- Nuclear Energy Series Technical Reports provide additional, more detailed information on activities relating to topics explored in the IAEA Nuclear Energy Series.

IAEA Nuclear Energy Series

Some Technical Reports:

- NF-T-3.1 *International Safeguards in the Design of Facilities for Long Term Spent Fuel Management*
- NF-T-3.3 *Storing Spent Fuel until Transport to Reprocessing or Disposal*
- NF-T-3.10 *Practices for Interim Storage of Research Reactor Spent Nuclear Fuel*
- NW-T-1.11 *Available Reprocessing and Recycling Services for Research Reactor Spent Nuclear Fuel*
- NW-T-1.14 (Rev.1) *Status and Trends in Spent Fuel and Radioactive Waste Management*
- NW-T-1.24 (Rev. 1) *Options for Management of Spent Nuclear Fuel and Radioactive Waste for Countries Developing New Nuclear Power Programmes*
- NW-T-1.25 *Costing Methods and Funding Schemes for Radioactive Waste Disposal Programmes*

- Countries should identify and develop policy and strategy for management of spent fuel and radioactive waste considering disposal as the final step
- A safety case and supporting safety assessments shall be used to guide all decisions on waste management, including disposal (safety first)
- All work shall be done in accordance with the management system



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Thank you!

