International Atomic Energy Agency

Safety Requirements for Disposal of Radioactive Waste

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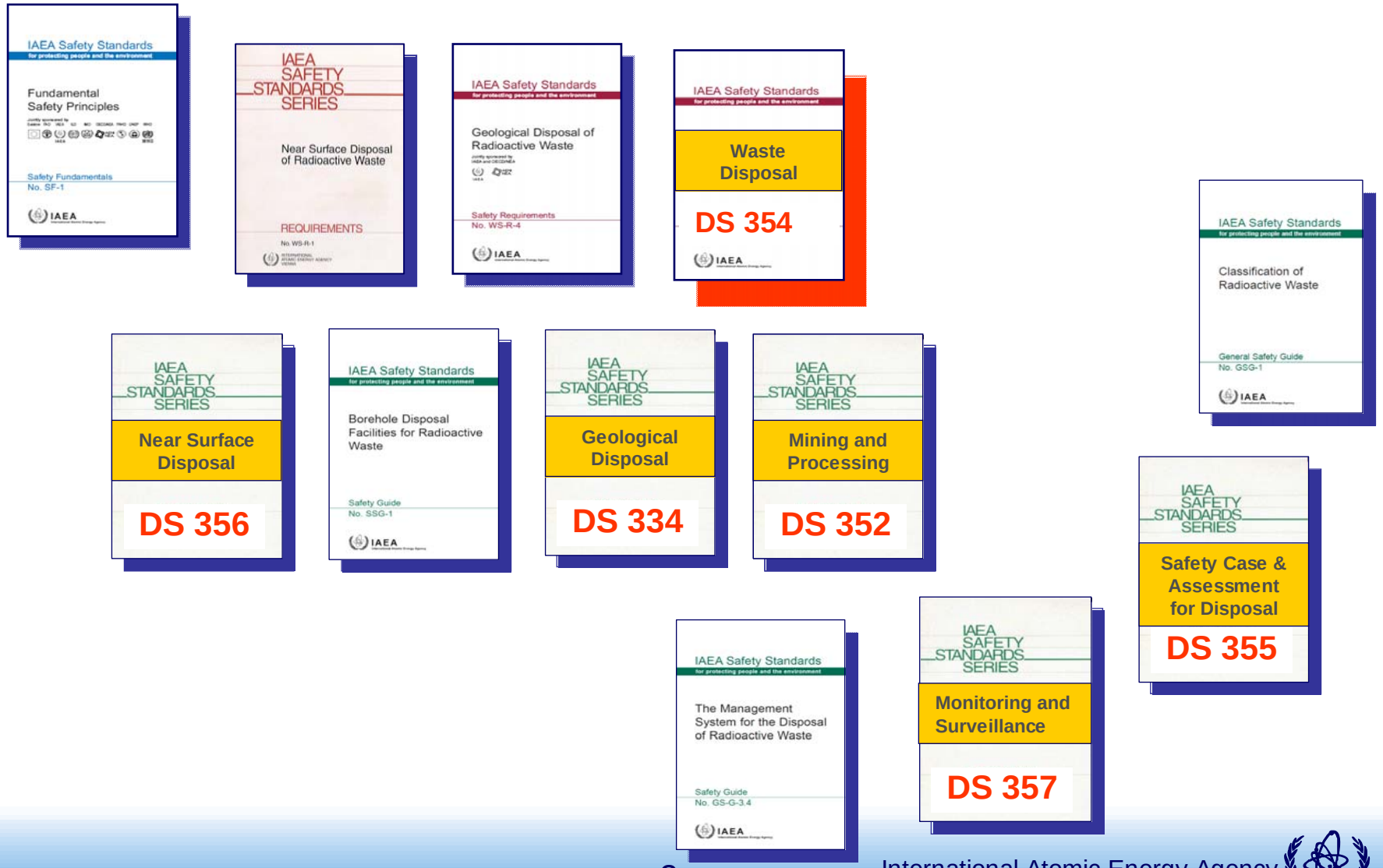
Safety Standards - Disposal



1. INTRODUCTION

2. PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

3. THE SAFETY REQUIREMENTS FOR THE DISPOSAL OF RADIOACTIVE WASTE

- REQUIREMENTS FOR PLANNING DISPOSAL FACILITIES
  - LEGAL AND ORGANIZATIONAL FRAMEWORK
  - SAFETY APPROACH
  - SAFETY DESIGN PRINCIPLES
- REQUIREMENTS FOR THE DEVELOPMENT, OPERATION AND CLOSURE OF DISPOSAL FACILITIES
  - FRAMEWORK FOR DISPOSAL
  - THE SAFETY CASE AND SAFETY ASSESSMENT
  - STEPS IN THE DEVELOPMENT, OPERATION AND CLOSURE OF DISPOSAL FACILITIES
- REQUIREMENTS FOR ASSURANCE OF SAFETY
- EXISTING DISPOSAL FACILITIES

1. INTRODUCTION

Scope

- Applies to the disposal of radioactive waste of all types
- Establishes requirements to provide assurance of radiological safety
  - During the operational period and
  - Especially in the post-closure period
- Does not address
  - Broader issues of site selection
  - Transportation of waste to the site
  - Non radiological environmental impact
- Stakeholder involvement important, but beyond the scope of the standard

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Post Closure Safety Criteria

- The dose limit for members of the public from all planned exposure situations is an effective dose of 1 mSv in a year, and this or its risk equivalent are considered criteria not to be exceeded in the future.
- To comply with this dose limit, a disposal facility (considered as a single source) is designed so that the estimated dose or risk to the *representative person* who may be exposed in the future as a result of ***natural processes*** affecting the disposal facility does not exceed a dose constraint of 0.3 mSv in a year or a risk constraint of the order of 10-5 per year.

Natural processes include the range of conditions anticipated during the lifetime of the facility and events that could occur with a lesser likelihood. Extremely low probability events would be outside the scope of consideration.

- In relation to the effects of **inadvertent human intrusion** in the post-closure period, if such intrusion is expected to lead to an annual dose of less than 1 mSv per year **to those living around the site**, efforts to reduce the probability of human intrusion or to limit its consequences are not warranted.
- If human intrusion is expected to lead to an annual dose of more than 20 mSv per year to those living around the site, alternative disposal options are to be considered, for example disposal of the waste below the surface, or separation of the radionuclide content giving rise to the higher dose.
- If annual doses in the range 1 – 20 mSv are indicated, reasonable efforts are justified at the facility development stage to reduce the probability of intrusion or to limit its consequences by optimization of the facility design.

< 1mSv	**1 – 20 mSv**	**> 20mSv**
Measures not warranted	**Measures considered**	**Alternative disposal**

SAFETY REQUIREMENTS
DISPOSAL OF RADIOACTIVE WASTE

REQUIREMENTS FOR PLANNING DISPOSAL FACILITIES

- LEGAL AND ORGANIZATIONAL FRAMEWORK
- SAFETY APPROACH
- SAFETY DESIGN PRINCIPLES

REQUIREMENTS FOR THE DEVELOPMENT, OPERATION AND CLOSURE OF DISPOSAL FACILITIES

- FRAMEWORK FOR DISPOSAL
- THE SAFETY CASE AND SAFETY ASSESSMENT
- STEPS IN THE DEVELOPMENT, OPERATION AND CLOSURE OF DISPOSAL FACILITIES

REQUIREMENTS FOR ASSURANCE OF SAFETY

EXISTING DISPOSAL FACILITIES

REQUIREMENTS FOR PLANNING DISPOSAL FACILITIES

LEGAL AND ORGANIZATIONAL FRAMEWORK

Requirement 1: Government responsibilities

The government is required to provide an appropriate national legal and organizational framework within which disposal facilities for radioactive waste can be sited, designed, constructed, operated and closed. This shall include: confirmation at a national level of the need for different types of disposal facilities; the definition of the steps in the development and licensing for different types of facility; the clear allocation of responsibilities, the securing of financial and other resources, and the provision of independent regulatory functions related to each planned disposal facility.

Requirement 2: Regulatory body responsibilities

The regulatory body shall establish the regulatory requirements for the development of each type of disposal facility and shall set out the procedures for meeting the requirements for the various stages of the licensing process. It shall also set conditions for the development, operation and closure of each individual disposal facility and shall carry out such activities as are necessary to ensure that the conditions are met.

Requirement 3: The responsibilities of the operator

The operator of a disposal facility shall be responsible for its safety. The operator shall carry out safety assessment and develop a safety case, and shall carry out all the necessary activities for siting, design, construction, operation, closure and, if necessary post closure surveys, according to national strategy, in compliance with the regulatory requirements and within the national legal infrastructure.

SAFETY APPROACH

Requirement 4: Importance of safety in the development process

Throughout the development of a disposal facility, an appropriate understanding of the relevance and implications for safety of the available options shall be developed by the operator, for achieving the ultimate goal of providing an optimized level of operational and post-closure safety.

Requirement 5: Passive safety

The operator shall site, design, construct, operate and close the disposal facility in such a way that safety is ensured by passive means to the extent possible and that the need for actions to be taken after the closure of the facility is minimized.

Requirement 6: Understanding and confidence in safety

The operator of a disposal facility shall develop an adequate understanding of the facility and its host environment and the factors that influence its post-closure safety over suitably long time periods, so that a sufficient level of confidence in safety is achieved.

SAFETY DESIGN PRINCIPLES

Requirement 7: Multiple safety functions

The host environment shall be selected and the engineered components of the facility designed and the facility operated so as to ensure that safety is provided by means of multiple safety functions. That is, containment and isolation of the waste shall be provided by means of a number of physical components of the disposal system whose performance is achieved by diverse physical and chemical processes together with the various operational controls. The capability of the individual components and controls together with that of the overall disposal system to perform as assumed in the safety case shall be demonstrated. The overall performance of the disposal system shall not be unduly dependent on a single safety function.

Requirement 8: Containment

The engineered components, including the waste form and packaging, shall be designed, and the host environment shall be selected, so as to provide containment of the waste during the period when radioactive decay has not yet significantly reduced the hazard posed by the waste and in the case of heat generating waste when the waste produces heat energy in amounts that could adversely affect the performance of the disposal system.

Requirement 9: Isolation

The disposal facility shall be sited, designed and operated to provide features that are aimed at isolation of the radioactive waste from the biosphere and from humans. The features shall aim to provide isolation for several hundreds of years for short lived waste and at least several thousand years for intermediate and high level waste. In doing so, consideration shall be given to both the natural evolution of the disposal system and disturbing events.

Requirement 10: Surveillance and control of passive safety features

An appropriate level of surveillance and control shall be applied in order to protect and preserve the passive safety barriers to the extent that this is needed in order to fulfil the functions that they are assigned in the post closure safety case.

FRAMEWORK FOR DISPOSAL

Requirement 11: Step by step development and evaluation

Disposal facilities shall be developed, operated and closed in a series of steps, each supported, as necessary, by iterative evaluations of the site, of the options for design, construction, operation and management, and of the performance and safety of the disposal system.

THE SAFETY CASE AND ASSESSMENT

Requirement 12: Preparation, approval and use of the safety case and assessment

A safety case and supporting safety assessment shall be prepared and updated by the operator, as necessary, at each step in the development, operation and post closure of a disposal facility. They shall be submitted to the regulatory body for approval. The safety case and supporting safety assessment shall be sufficiently detailed and comprehensive to provide the necessary technical input for informing the regulatory and other decisions needed at each step.

- Progressively developed and elaborated as the project proceeds
- Formality and level of technical detail of the safety case depend on the stage of development of the project
- Establish waste acceptance criteria
- Identifies key processes relevant to safety

Requirement 13: Scope of the safety case and assessment

The safety case for a disposal facility shall describe all the safety relevant aspects of the site, the design of the facility, and the managerial and regulatory controls. The safety case and supporting safety assessment shall demonstrate the level of protection provided and shall provide assurance to the regulatory body and other interested parties that safety requirements will be met.

- Operational safety and post-closure safety
- Occupational exposure and public exposure
- Normal operations, including anticipated occurrences
- Accidents of lesser frequency but significant radiological consequences
- Demonstrate disposal system, its possible evolutions and relevant events that might affect it are sufficiently well understood
  - feasibility of implementing the design
  - convincing estimates of the performance of the disposal system
  - reasonable assurance that all the relevant safety requirements will be complied with and radiation protection optimized
  - analysis of the associated uncertainties
- Quantitative assessment over the time period for which regulatory compliance is required - results likely to be more uncertain for time periods in the far future
- Management systems

Requirement 14: Documentation of the safety case and assessment

The safety case and supporting safety assessment shall be documented to a level of detail and quality sufficient to inform and support the decision to be made at each step and to allow for their independent review.

- Important considerations are justification, traceability and clarity
- Justification concerns explaining the basis for the choices
- Traceability concerns the ability of an independent qualified person to follow what has been done
- Clarity concerns good structure and presentation at an appropriate level of detail so as to allow an understanding of the safety arguments

STEPS IN THE DEVELOPMENT, OPERATION AND CLOSURE OF DISPOSAL FACILITIES

Requirement 15: Site characterization

The site for a disposal facility shall be characterized at a level of detail sufficient to support both a general understanding of the characteristics of the site, including its present condition, its probable natural evolution, possible natural events and also human plans and actions that may affect the facility or its vicinity over the period of interest with regard to safety, and a specific understanding of the impact on safety of features, events and processes associated with the site and the facility.

Requirement 16: Design

The disposal facility and its engineered barriers shall be designed to contain the waste with its associated hazard, to be physically and chemically compatible with the host geological and/or surface environment, and to provide post-closure safety features that complement those afforded by the host environment. The facility and its engineered components shall also be designed to provide for safety during the operational period.

Requirement 17: Construction

A disposal facility shall be constructed in accordance with the design as described in the approved safety case and supporting safety assessment. It shall be constructed in such a way as to preserve the post-closure safety functions of the host environment that have been shown to be important by the safety case. The construction activities shall be carried out to ensure safety during the operational period.

Requirement 18: Operation

A disposal facility shall be operated in accordance with the conditions of the licence and the relevant regulatory requirements to maintain safety during the operational period, and in such a manner as to preserve the post-closure safety functions assumed in the safety case.

Requirement 19: Closure

A disposal facility shall be closed in such a way that provides for the safety functions shown by the safety case to be important for the post-closure period. Plans for closure, including the transition from active management of the facility, shall be well defined and practicable, so that closure can be carried out safely at an appropriate time.

REQUIREMENTS FOR ASSURANCE OF SAFETY

Requirement 20: Waste acceptance

Waste packages and unpackaged waste accepted for emplacement in a disposal facility shall conform to criteria fully consistent with and derived from the safety case for the operational and post-closure safety of the disposal facility.

Requirement 21: Monitoring programmes

A programme of monitoring shall be carried out prior to and during the construction and operation of a disposal facility, and after closure, if this is part of the safety case. This programme shall be designed to collect and update the information needed to confirm the conditions necessary for the safety of workers and members of the public and the protection of the environment during the operation of the facility and to confirm the absence of any conditions that could reduce the post-closure safety of the facility.

Requirement 22: Post-closure and institutional controls

An appropriate level of surveillance and control shall be applied in order to protect and preserve the passive safety barriers to the extent that this is needed in order to fulfil the functions that they are assigned in the post closure safety case. Plans shall be prepared to address such surveillance and control and the arrangements for maintaining the availability of information on the disposal facility. These plans shall form part of the safety case on which authorization to close the facility is granted.

- Long-term safety not rely on active institutional control
- Violation of passive measures will not give rise to the criteria for intervention being exceeded
- Institutional controls not be sole or main component of safety for near surface disposal
- Ability of institutional controls to provide contribution to safety envisaged in the safety case demonstrated and justified in safety case
- Geological and intermediate depth disposal - passive safety barriers sufficiently robust, unlikely to need repair or upgrading
- Intent of surveillance and monitoring - not to measure radiological parameters but to ensure the continuing presence of safety functions

Requirement 22: Post-closure and institutional controls

- Near surface facilities generally designed on the assumption that institutional control will remain in force for a period of time
- Near surface disposal of mining and minerals processing waste (very long half lives, large volumes) activity concentrations limited so safety does not rely on ongoing active institutional control - waste with greater activity concentrations disposed below surface
- Status of disposal facility beyond period of active institutional control - release of the site for unrestricted use generally not contemplated.
- Site location and the facility design will have reduced the likelihood of human intrusion
- Near surface facilities - waste acceptance criteria limit consequences of human intrusion to specified criteria even if control over site lost
- Geological and intermediate depth disposal facilities not rely on long term post-closure institutional control as passive safety function
- Whilst facility licensed operator provides control - following licence termination responsibility will revert to government

Requirement 23: Consideration of the System of accounting for and control of nuclear material

In the design and operation of disposal facilities subject to agreements on accounting and control of nuclear material, consideration shall be given to ensuring that safety is not compromised by the measures required under the system of accounting for and control of nuclear material.

Requirement 24: Requirements in respect of security measures

Measures shall be implemented to ensure an integrated approach to safety measures and nuclear security measures in the disposal of radioactive waste.

Requirement 25: Management systems

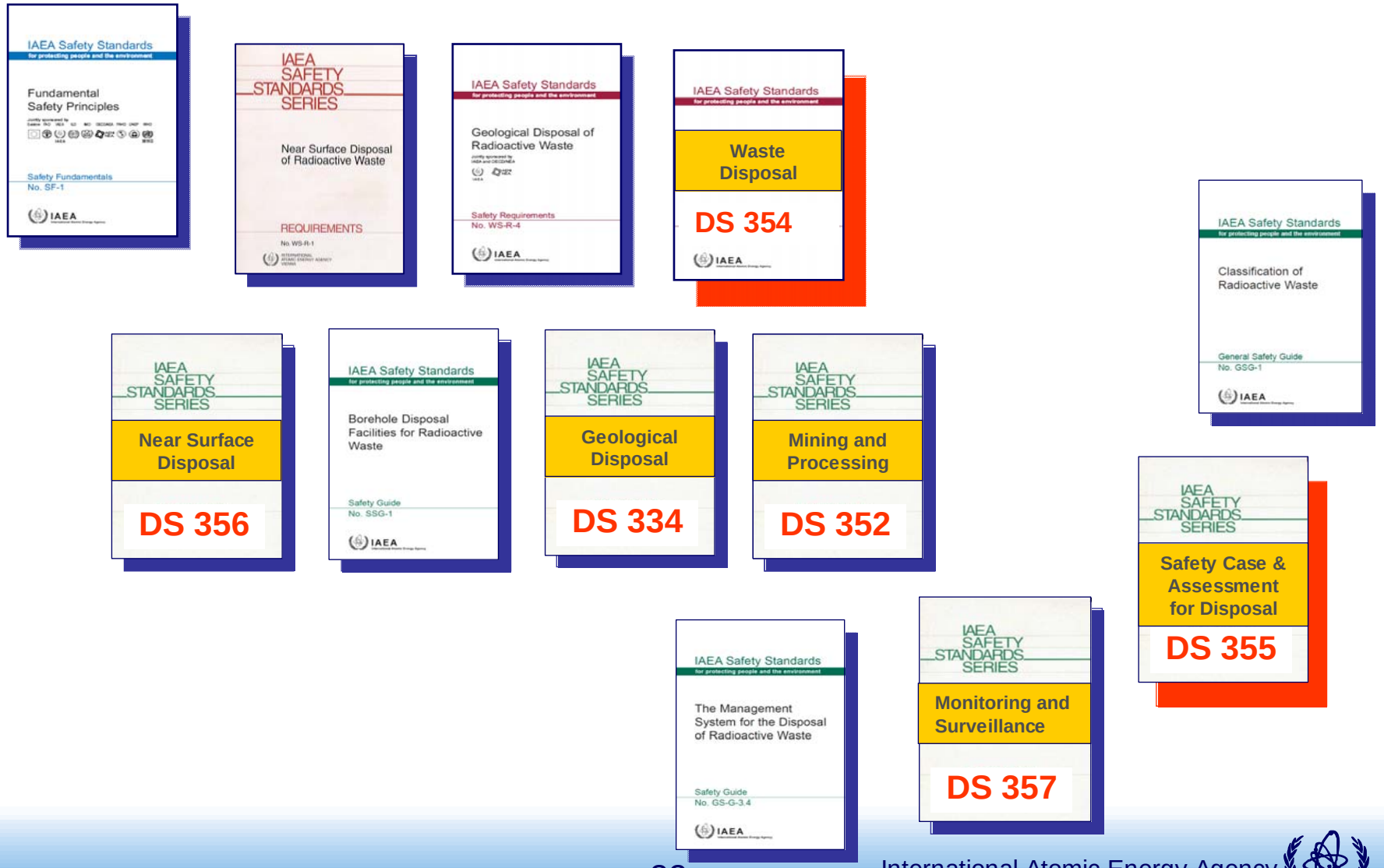
Management systems to provide for the assurance of quality shall be applied to all safety related activities, systems and components throughout all the steps of the development and operation of a disposal facility. The level of assurance for each element shall be commensurate with its importance to safety.

EXISTING DISPOSAL FACILITIES

Requirement 26: Existing disposal facilities

The safety of existing disposal facilities shall be assessed periodically until licence termination and when a safety significant modification is planned or when changes with respect to the authorized conditions happen. In the event that any safety requirements set down in this publication are not met, measures shall be put in place to upgrade the safety of the facility, economic and social factors being taken into consideration.

Safety Standards - Disposal



Contents

Stakeholder & Regulatory Involvement
Safety Case Context
• Safety objectives
• Safety principles
• Regulations
Safety Strategy
• Isolation, Containment
•Passive systems, robustness
•Defence in depth, demonstrability
Management System
Iteration & Design Optimization
System Description
Site and waste characteristics, Safety Functions, Design Options
Management of Uncertainty
Assessments
Management System
Environmental Impact
Post-Closure radiological impact
Operational Safety
Site / Engineering
Limits & conditions e.g. WAC
Integration of Safety Arguments
Demonstration of robustness, defence in depth
system understanding, monitoring, etc