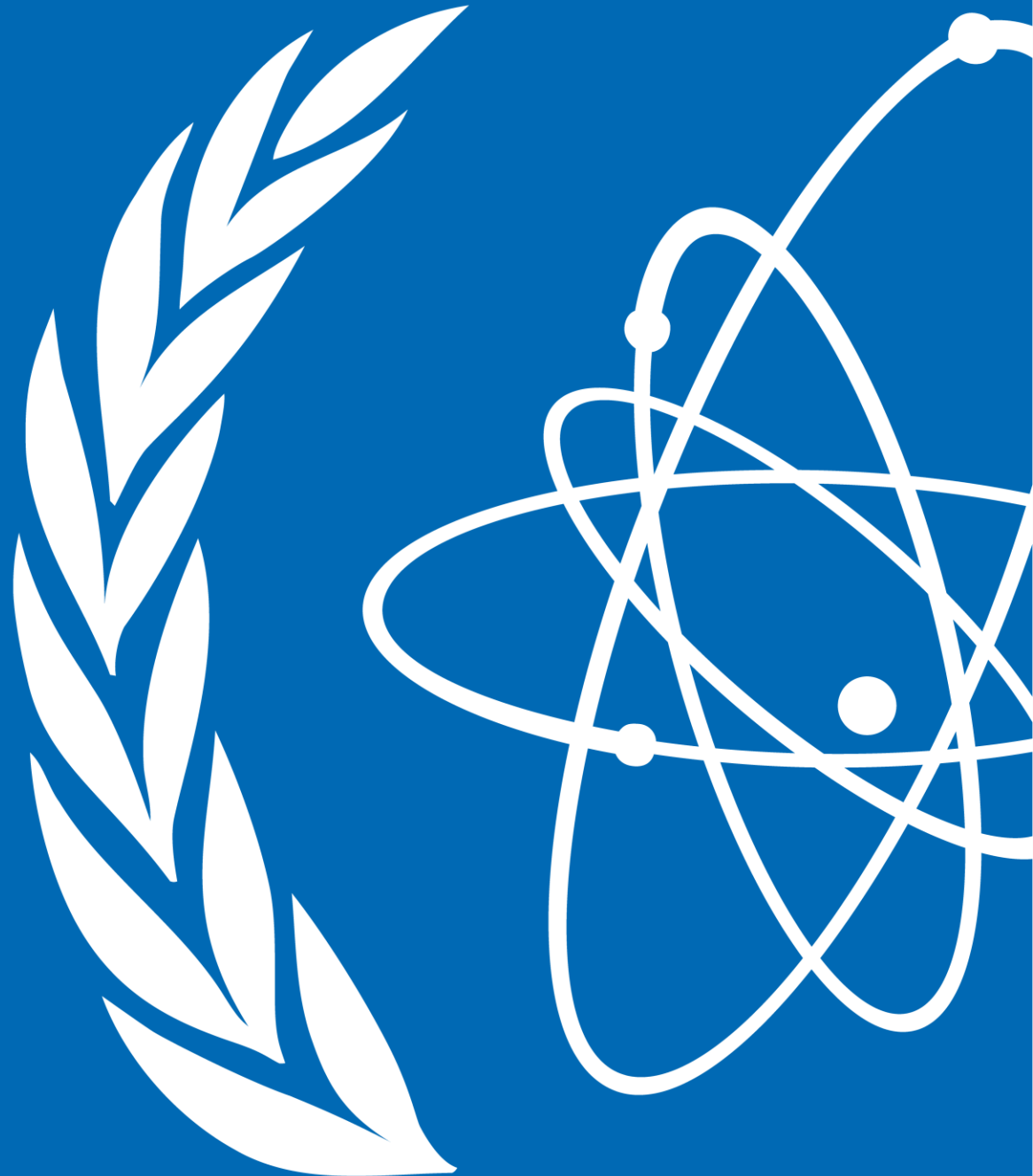


P12. Overview of IAEA Safety Standards for Design Safety

Jorge LUIS HERNANDEZ
Team Lead Design Safety
Safety Assessment Section





SAFETY STANDARDS

ARTICLE III: Functions

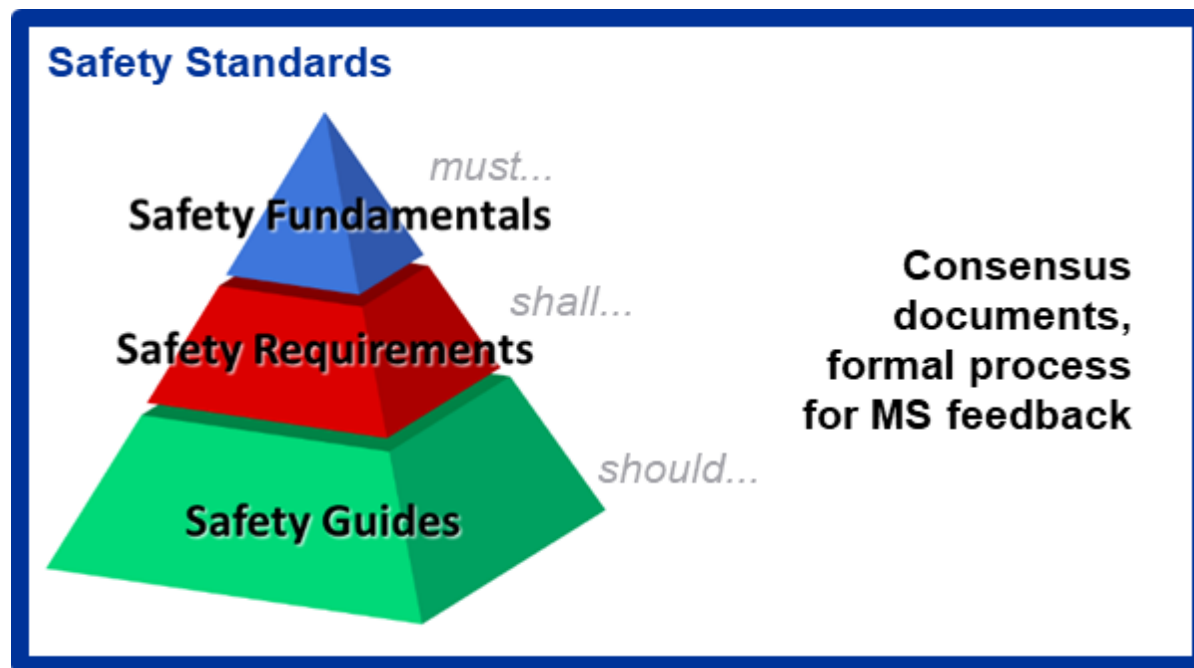
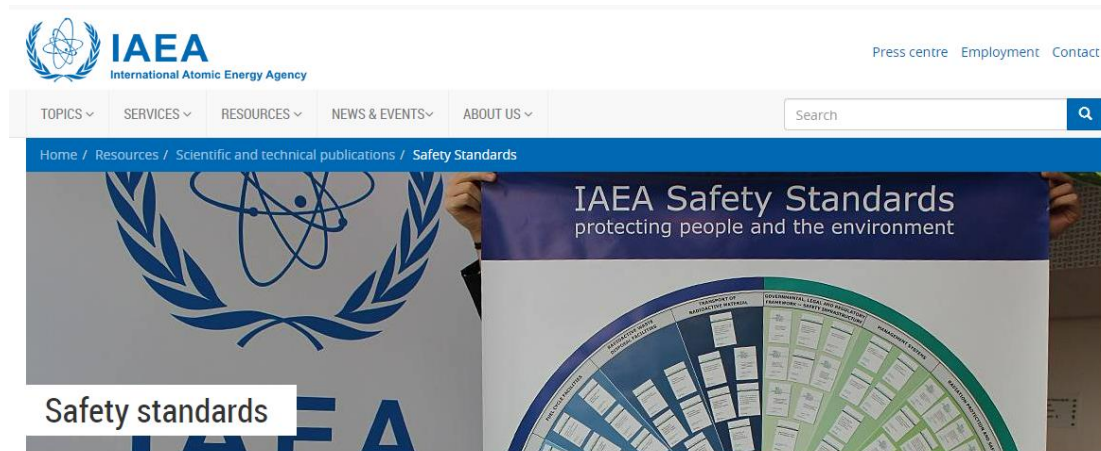
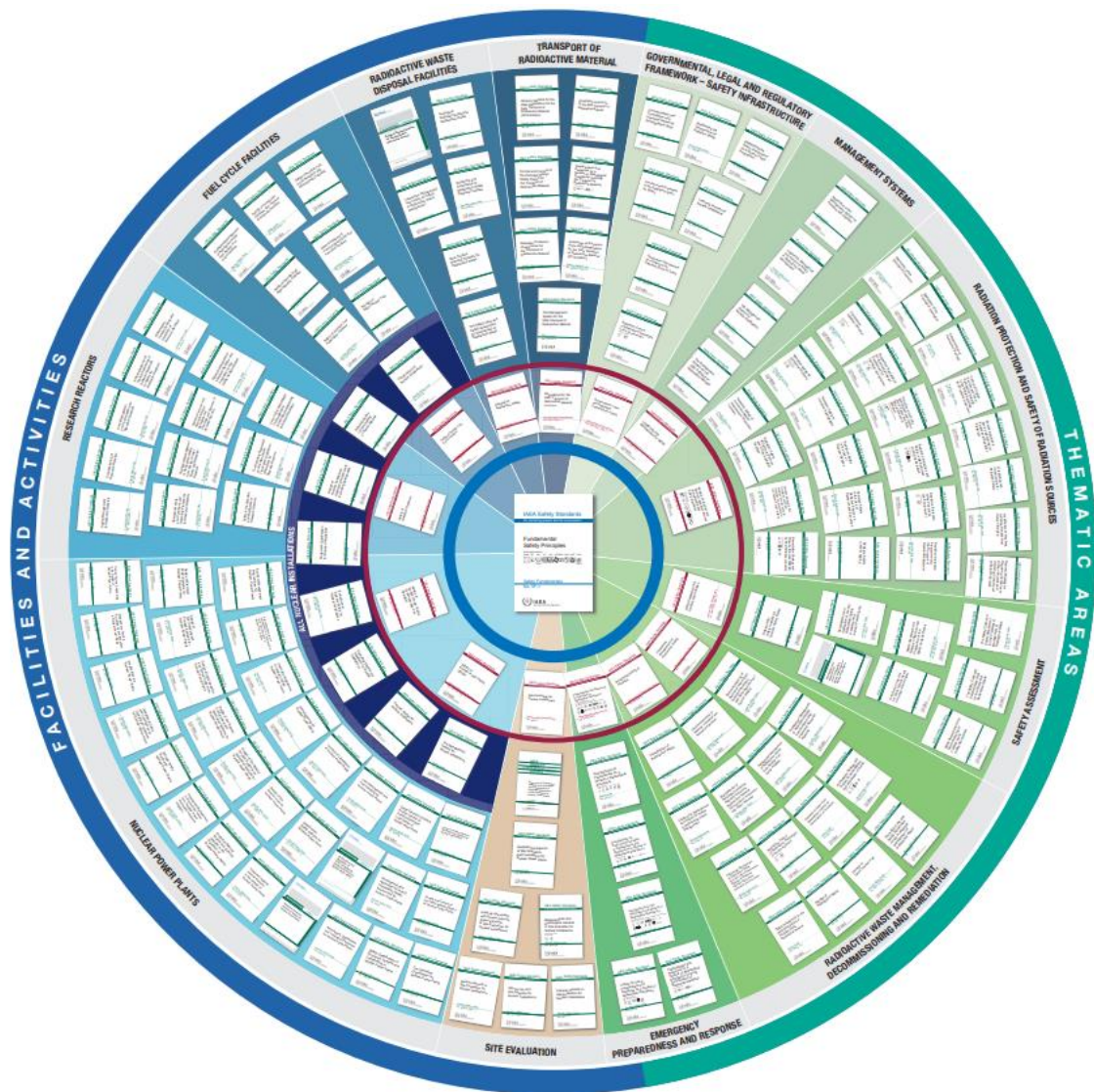
A. The Agency is authorized:

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 operations as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision; and to provide for the application of these standards, 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 atomic energy;



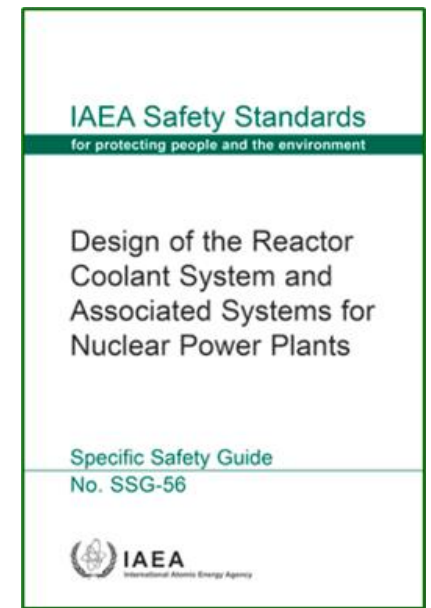
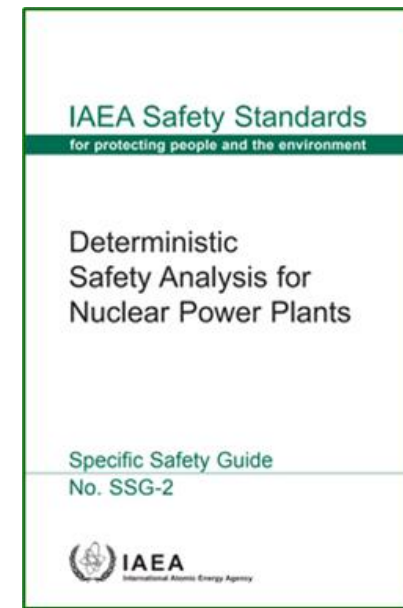
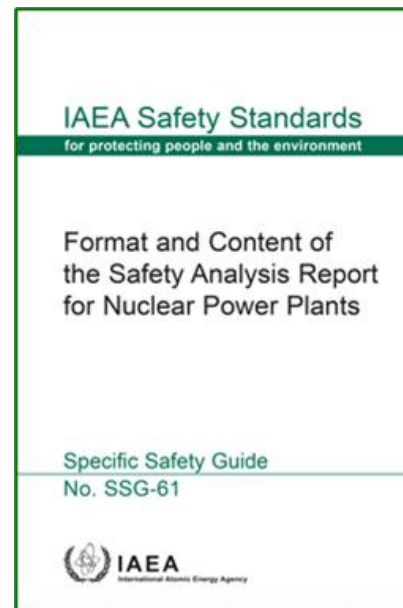
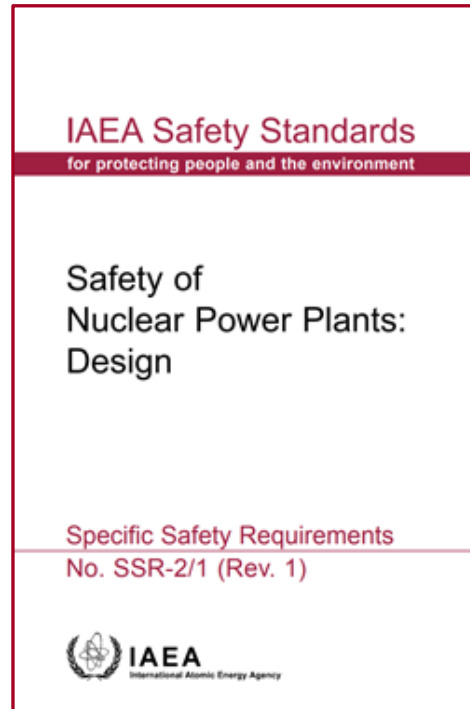
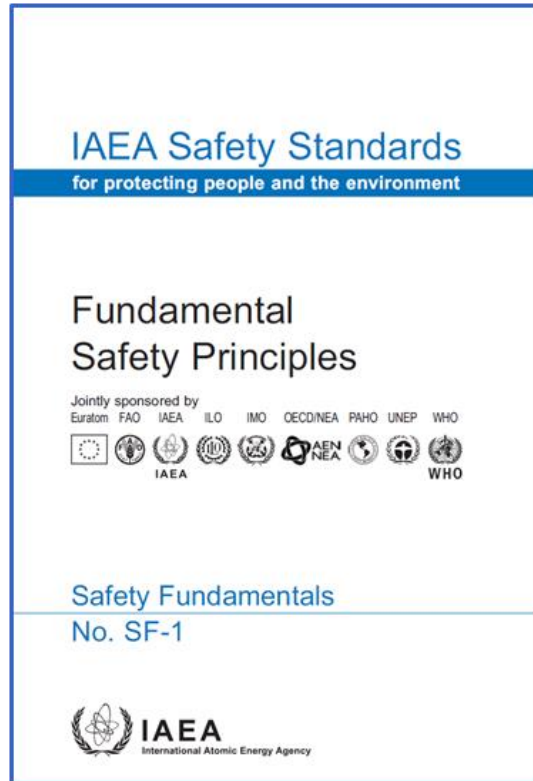
Contents by Article and Title

I. Establishment of the Agency	XIII. Reimbursement of Members
II. Objectives	XIV. Finance
III. Functions	XV. Privileges and immunities
IV. Membership	XVI. Relationship with other organizations
V. General Conference	XVII. Settlement of disputes
VI. Board of Governors	XVIII. Amendments and withdrawals
VII. Staff	XIX. Suspension of privileges
VIII. Exchange of information	XX. Definitions
IX. Supplying of materials	XXI. Signature, acceptance, and entry into force
X. Services, equipment, and facilities	XXII. Registration with the United Nations
XI. Agency projects	XXIII. Authentic texts and certified copies
XII. Agency safeguards	ANNEX Preparatory Commission



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

SAFETY STANDARDS | IAEA



To access IAEA Safety Standards
Series, please visit [here](#)



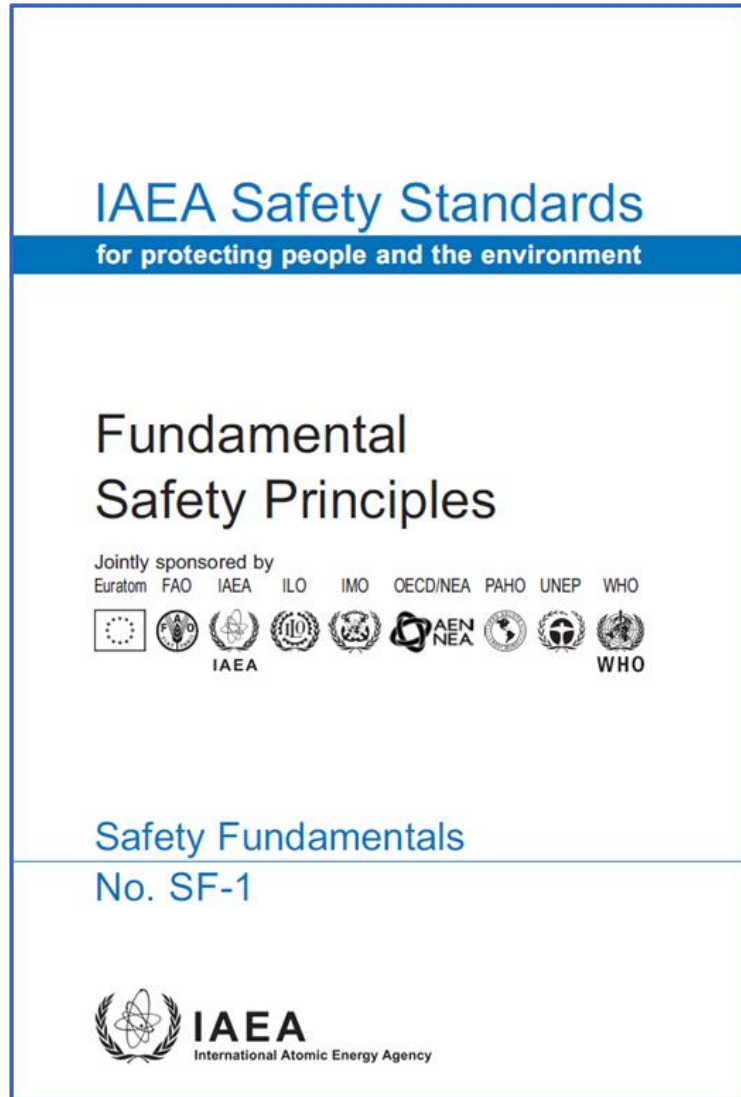
THESE ARE NOT SAFETY STANDARDS:



They describe good practices, experiences, and challenges for specific topics

... but they are not consensus documents

FUNDAMENTAL SAFETY PRINCIPLES



SAFETY OBJECTIVE

The fundamental safety objective is to protect people and the environment from harmful effects of ionizing radiation

SAFETY PRINCIPLES

- **Principle 1:** Responsibility for safety
- **Principle 2:** Role of government
- **Principle 3:** Leadership and management for safety
- **Principle 4:** Justification of facilities and activities
- **Principle 5:** Optimization of protection
- **Principle 6:** Limitation of risks to individuals
- **Principle 7:** Protection of present and future generations
- **Principle 8:** Prevention of accidents
- **Principle 9:** Emergency preparedness and response
- **Principle 10:** Protective actions to reduce existing or unregulated radiation risks

FUNDAMENTAL SAFETY PRINCIPLES



SAFETY OBJECTIVE

The fundamental objective of nuclear safety is to protect people and the environment from the harmful effects of ionizing radiation

MUST

Principle 10: Protective actions to reduce existing or unregulated radiation risks

IAEA SAFETY STANDARDS – SAFETY REQUIREMENTS

IAEA Safety Standards for protecting people and the environment Site Evaluation for Nuclear Installations Specific Safety Requirements No. SSR-1  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Safety of Nuclear Power Plants: Design Specific Safety Requirements No. SSR-2/1 (Rev. 1)  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Safety of Nuclear Power Plants: Commissioning and Operation Specific Safety Requirements No. SSR-2/2 (Rev. 1)  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Safety of Research Reactors Specific Safety Requirements No. SSR-3  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Safety of Nuclear Fuel Cycle Facilities Specific Safety Requirements No. SSR-4  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Disposal of Radioactive Waste Specific Safety Requirements No. SSR-5  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Regulations for the Safe Transport of Radioactive Material 2018 Edition Specific Safety Requirements No. SSR-6 (Rev. 1)  IAEA International Atomic Energy Agency
IAEA Safety Standards for protecting people and the environment Governmental, Legal and Regulatory Framework for Safety General Safety Requirements No. GSR Part 1 (Rev. 1)  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Leadership and Management for Safety General Safety Requirements No. GSR Part 2  IAEA International Atomic Energy Agency	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, ILO, OECD/NEA, PAHO, UNEP, WHO  General Safety Requirements Part 3 No. GSR Part 3  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Safety Assessment for Facilities and Activities General Safety Requirements No. GSR Part 4 (Rev. 1)  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Predisposal Management of Radioactive Waste General Safety Requirements Part 5 No. GSR Part 5  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Decommissioning of Facilities General Safety Requirements Part 6 No. GSR Part 6  IAEA International Atomic Energy Agency	IAEA Safety Standards for protecting people and the environment Preparedness and Response for a Nuclear or Radiological Emergency Jointly sponsored by the FAO, IAEA, ICAO, ILO, IMO, INTERPOL, OECD/NEA, PAHO, CTBTO, UNEP, OCHA, WHO, WMO  General Safety Requirements No. GSR Part 7  IAEA International Atomic Energy Agency

IAEA SAFETY STANDARDS – SAFETY REQUIREMENTS



Safety approach for the design of NPPs

Safety
Objective

**Protect people and the environment from harmful
effects of ionizing radiation**

Principles

P5. Optimization of Protection

P6. Limitation of Risks to Individuals

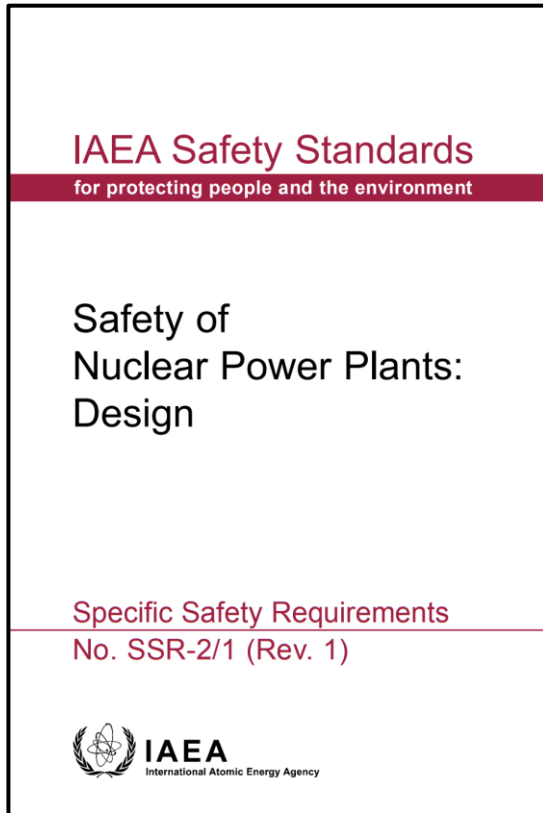
P7. Protection of Present and Future Generations

P8. Prevention of Accidents

P9. Emergency Preparedness and Response

prerequisites

SSR 2/1 (Rev. 1): Safety of Nuclear Power Plants: Design



Published in 2016, revised to consider the main observations and lessons from the accident at the Fukushima Daiichi Nuclear Power Plant

The review revealed no significant areas of weakness and resulted in a small set of amendments to strengthen the requirements and facilitate their implementation

Requirements applicable to the NPP design and elaborates on the safety objective, safety principles and concepts that provide the basis for deriving the safety requirements that must be met for the NPP design

- Useful for organizations involved in design, manufacture, construction, modification, maintenance, operation and decommissioning of NPP, as well as for regulatory bodies

IAEA Safety Standards

for protecting people and the environment

Safety of Nuclear Power Plants: Design

Specific Safety Requirements

No. SSR-2/1 (Rev. 1)



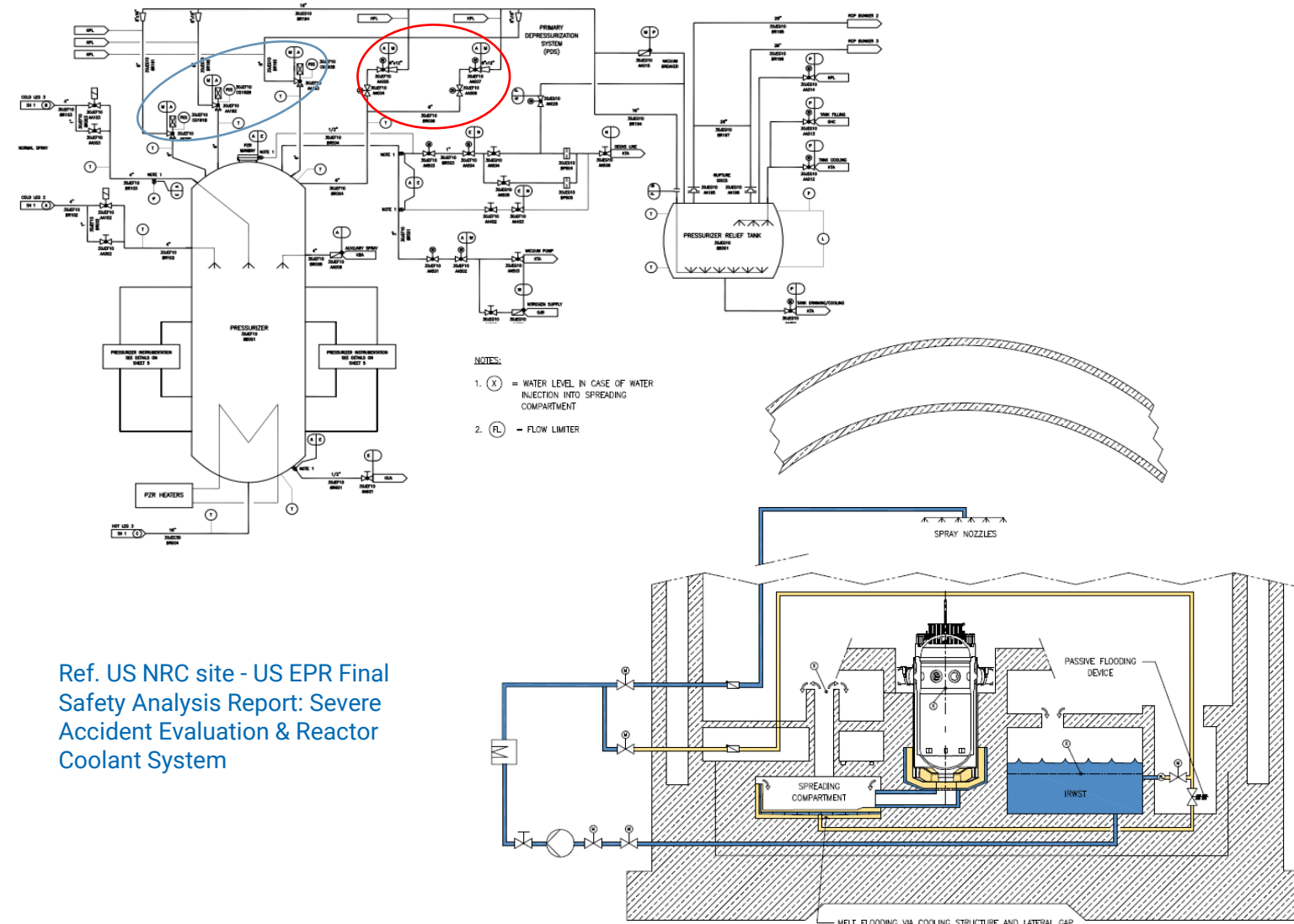
82 REQUIREMENTS:

- Management of safety in design **(R1 to R3)**
- Principal technical requirements **(R4 to R12)**
- General plan design:
 - Design basis **(R13 to R28)**
 - Design for safe operation over the lifetime of the plant **(R29 to R31)**
 - Human factors **(R32)**
 - Other design considerations **(R33 to R41)**
 - Safety analysis **(R42)**
- Design of specific systems:
 - Reactor core and associated features **(R43 to R46)**
 - Reactor coolant systems **(R47 to R53)**
 - Containment structure and containment system **(R54 to R58)**
 - I&C systems **(R59 to R67)**
 - Emergency power supply **(R68)**
 - Supporting systems and auxiliary systems **(R69 to R76)**
 - Other power conversion systems **(R77)**
 - Treatment of radioactive effluents and radioactive waste **(R78 - R79)**
 - Fuel handling and storage systems **(R80)**
 - Radiation protection **(R81 – R82)**

A few concepts

- Technology neutral: High level requirements not related to a technology (e.g. Requirements 1, 2, 3 of SSR-2/1 (Rev. 1)).
- Technology inclusive: Proposing requirements that aim at encompassing all or a part of the collection of reactor technologies (e.g. Requirements of section Principal Technical Requirements in SSR-2/1 (Rev. 1))
- Technology specific: WCR, HTGR, FNR, MSR (e.g. Requirements of section Design of Specific Plant Systems in SSR-2/1 (Rev. 1))
- Design specific: Related to specific features for a given design. (e.g. Russian PWR (VVER) vs PWR Westinghouse designs in SSGs)

SSR 2/1 (Rev. 1): Safety of Nuclear Power Plants: Design (1/5)



Ref. US NRC site - US EPR Final Safety Analysis Report: Severe Accident Evaluation & Reactor Coolant System

Reinforce the application of the Defence-in-Depth concept, by implementing independent Defence-in-Depth provisions, mainly between provisions required for levels 3 and 4

SSR 2/1 (Rev. 1): Safety of Nuclear Power Plants: Design (2/5)



Construction 18m embankment to protect against tsunami Hamaoka NPP, Japan

Stressing the need for sufficient and adequate margins to avoid cliff edge effects. For items that ultimately prevent large or early releases, margins are required also for hazards more severe than those selected for the design basis

SSR 2/1 (Rev. 1): Safety of Nuclear Power Plants: Design (3/5)



Wolsong NPP, Republic of Korea

Multi-unit site considerations related to the independence of dedicated, to each unit, safety systems for DBA and additional safety features for DEC.

DBA=Design Basis Accidents

DEC=Design Extension Conditions

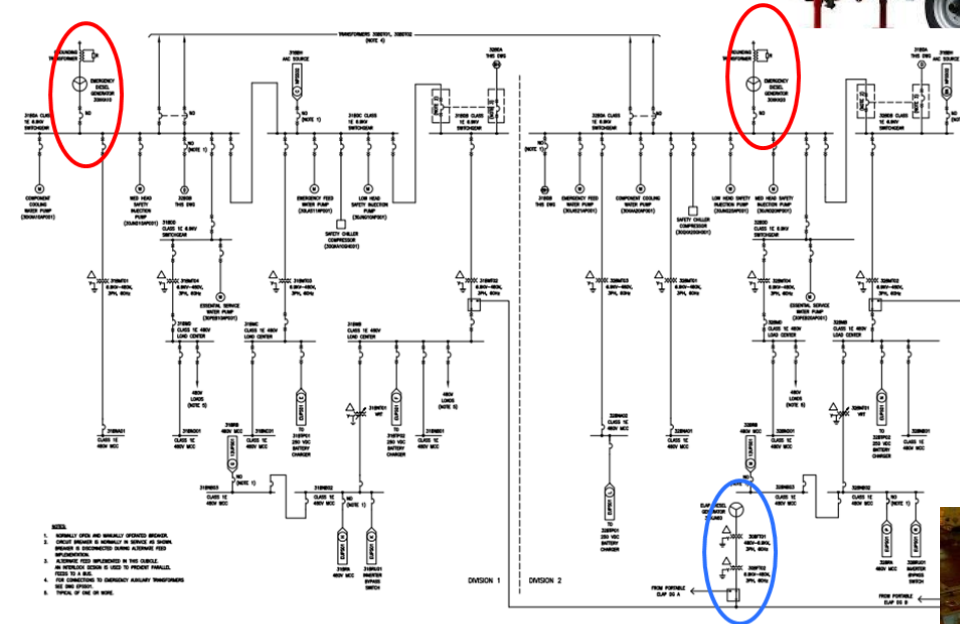
- Reinforced capabilities for heat transfer to the UHS. Alternative heat sink or different access is required if heat transfer cannot be ensured in conditions generated by hazards more severe than those selected for the design basis

18

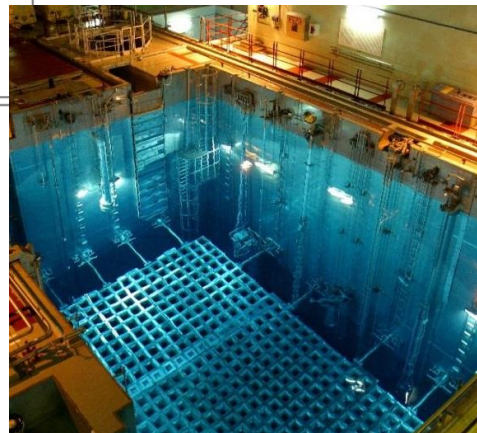
SSR 2/1 (Rev. 1): Safety of Nuclear Power Plants: Design (5/5)



- Implementation of features (design, procedures, etc.) to enable the use of non permanent equipment
- Reinforced capabilities for power supply in DEC's
- Additional measures for spent fuel pool instrumentation, cooling and maintaining inventory



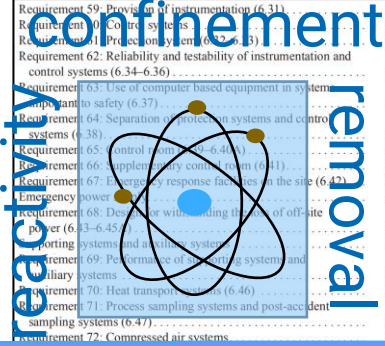
Ref. US NRC site - US EPR Final Safety Analysis Report: Electrical power distribution



SSR 2/1 (Rev. 1) : Table of contents (2/2)



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Requirement 5: Radiation Protection in Design

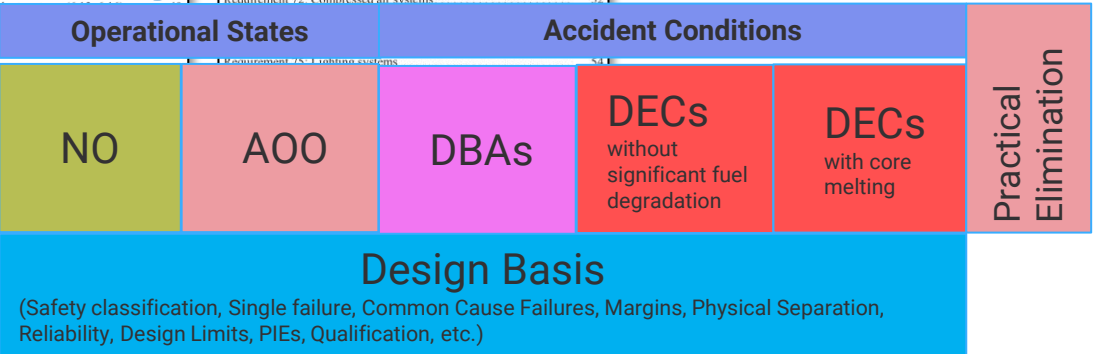
Requirement 4: Fundamental Safety Functions

Requirement 16: Postulated Initiating Events

Requirement 13: Categories of Plant States

Requirement 14: DB for items important to Safety

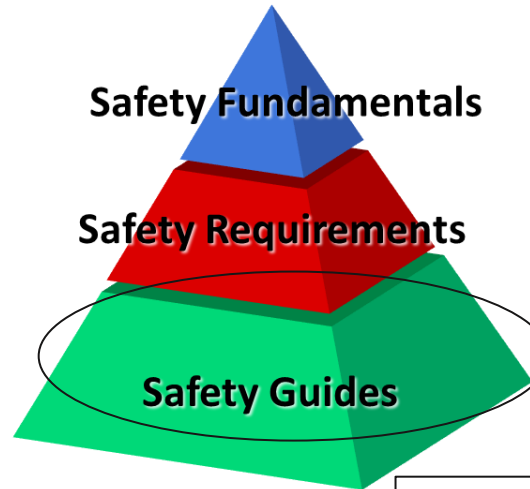
Requirement 7: Application of Defence in Depth



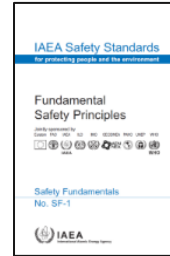
Level 1	Level 2	Level 3	Level 4	Level 5
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+Concept of Practical Elimination₂₀

Design Safety



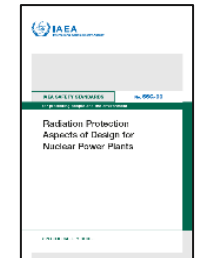
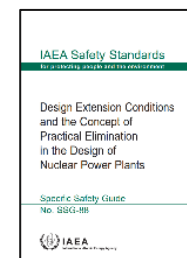
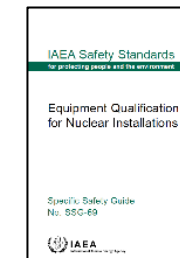
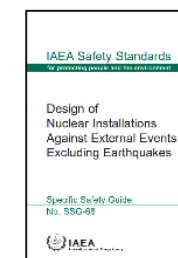
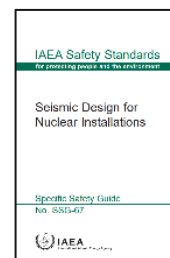
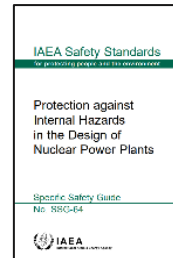
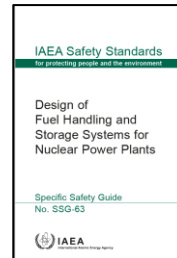
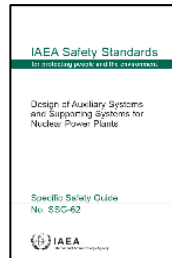
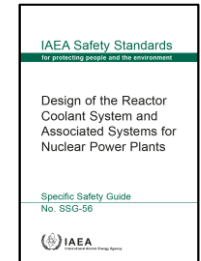
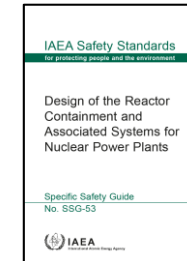
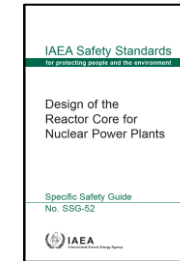
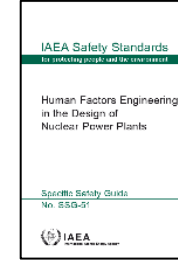
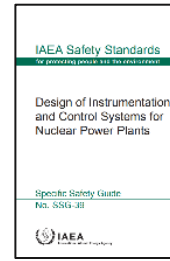
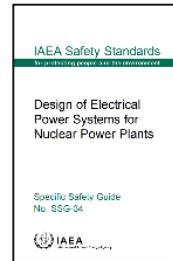
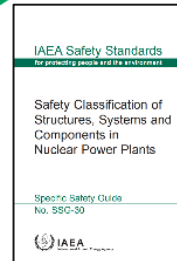
Safety objectives and safety principles



Functional conditions required for safety



Guidance on how to fulfil the requirements



IAEA Safety Standards

for protecting people and the environment

Safety Assessment for Facilities and Activities

General Safety Requirements

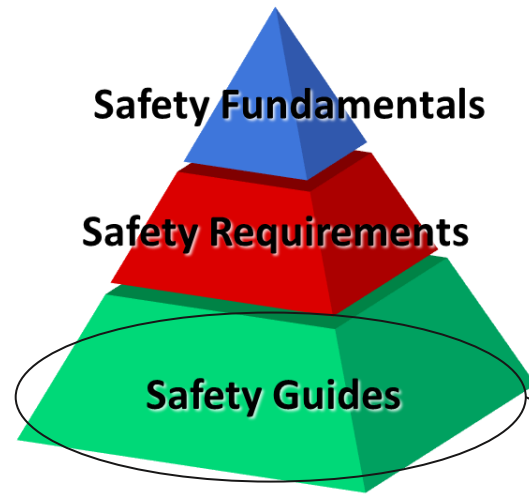
No. GSR Part 4 (Rev. 1)



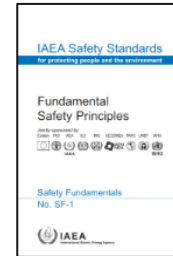
24 REQUIREMENTS:

- **Graded approach** for Safety Assessment **(R1)**
- **Scope, purpose**, responsibility and preparation for SA **(R2 to R5)**
- **Assessment of:**
 - **Possible radiation risks (R6)**
 - **Safety functions, site, radiation protection (R7 to R9)**
 - Engineering aspects and human factors (R10 to R11)
 - Safety over lifetime of a facility or activity **(R12)**
 - **Assessment of defence in depth (R13)**
- **Safety Analysis**
 - Scope of safety analysis **(R14)**
 - **Deterministic and probabilistic approaches (R15)**
 - Criteria, uncertainties and sensitivities **(R16 to R17)**
 - Use of computer codes and operating experience **(R18 to R19)**
- Documentation (R20)
- **Independent verification (R21)**
- Management, use and maintenance of the safety assessment **(R22 to R24)**

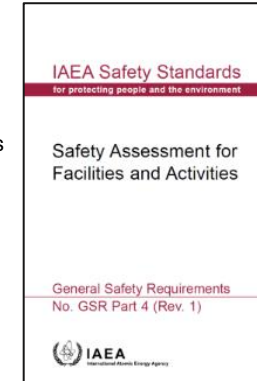
Safety assessment



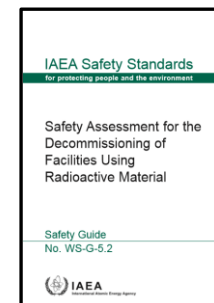
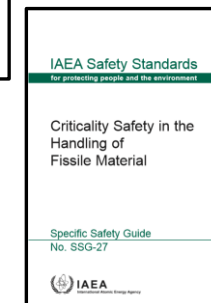
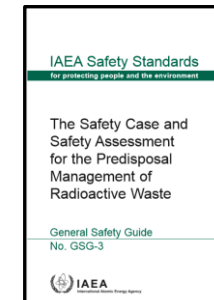
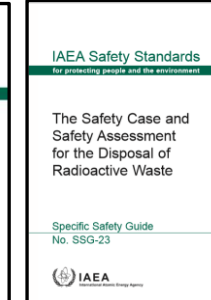
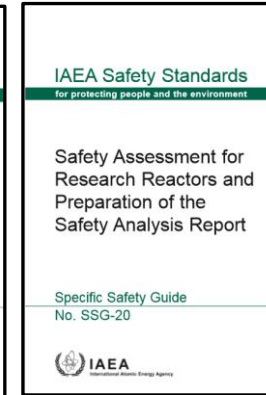
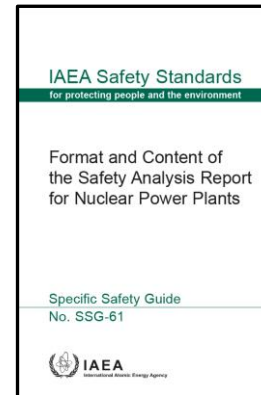
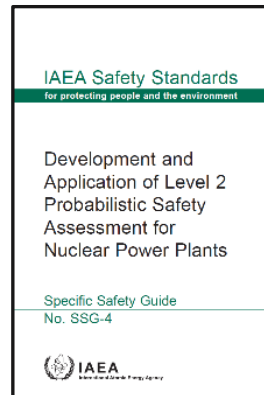
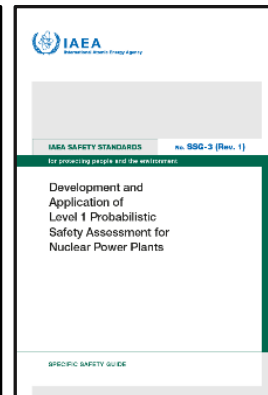
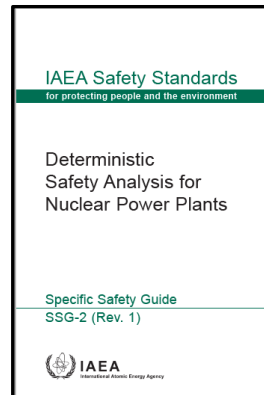
Safety objectives and
safety principles



Functional conditions
required for safety



Guidance on how to
fulfil the requirements



IAEA Safety Standards

for protecting people and the environment

Format and Content of the Safety Analysis Report for Nuclear Power Plants

Specific Safety Guide

No. SSG-61



IAEA

International Atomic Energy Agency

CONTENT AND STRUCTURE OF THE SAR

Chapter 1: Introduction and general considerations

Chapter 2: Site characteristics

Chapter 3: Safety objectives and design rules for structures, systems and components

Chapter 4: Reactor

Chapter 5: Reactor coolant system and associated systems

Chapter 6: Engineered safety features

Chapter 7: Instrumentation and control

Chapter 8: Electrical power

Chapter 9: Auxiliary systems and civil structures

Chapter 10: Steam and power conversion systems

Chapter 11: Management of radioactive waste

Chapter 12: Radiation protection

Chapter 13: Conduct of operations

Chapter 14: Plant construction and commissioning

Chapter 15: Safety analysis

Chapter 16: Operational limits and conditions for safe operation

Chapter 17: Management for safety

Chapter 18: Human factors engineering

Chapter 19: Emergency preparedness and response

Chapter 20: Environmental aspects

Chapter 21: Decommissioning and end of life aspects

IAEA Safety Standards

for protecting people and the environment

Format and Content of the Safety Analysis Report for Nuclear Power Plants

Specific Safety Guide
No. SSG-61



IAEA
International Atomic Energy Agency

CONTENT AND STRUCTURE OF THE SAR

Chapter 1: Introduction and general considerations

Chapter 2: Site characteristics

Chapter 3: Safety objectives and design of safety systems and components

Chapter 4: Reactor

Chapter 5: Reactor cooling

Chapter 6: Engineering

Chapter 7: Instrumentation

Chapter 8: Quality assurance

Chapter 9: Construction and commissioning

Chapter 10: Safety analysis

Chapter 11: Operational limits and conditions for safe operation

Chapter 12: Management for safety

Chapter 13: Human factors engineering

Chapter 14: Emergency preparedness and response

Chapter 15: Environmental aspects

Chapter 16: Decommissioning and end of life aspects

Chapter 17: Decommissioning and end of life aspects

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Appendix 1

TABLE 1. INFORMATION INCLUDED IN THE SAFETY ANALYSIS REPORT ISSUED FOR DIFFERENT LICENSING STAGES OF THE NUCLEAR POWER PLANT

Chapter of the safety analysis report	Licensing stages		
	Site permit: Initial SAR	Construction permit: Preliminary SAR	Commissioning: Pre-operational SAR (final SAR)
1 Introduction and general considerations	Preliminary information	Final information	Verified and updated information
2 Site characteristics	Final information	Verified information	Verified and updated information
3 Safety objectives and design rules for structures, systems and components	General design requirements	Design requirements specific to the reactor type	Verified and updated information

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Annex

TYPICAL TABLE OF CONTENTS OF A SAFETY ANALYSIS REPORT

CHAPTER 1: Introduction and general considerations

- 1.1. Introduction
- 1.2. Project implementation
- 1.3. Identification of interested parties regarding design, construction and operation
- 1.4. Information on the plant layout and other aspects
- 1.5. General plant description
- 1.6. Comparison with other plant designs
 - 1.6.1. Additional information concerning new safety features
- 1.7. Drawings and other more detailed information
- 1.8. Modes of normal operation of the plant
- 1.9. Principles of safety management
- 1.10. Additional supporting or complementary documents to the safety analysis report
- 1.11. Conformance with applicable regulations, codes and standards

CHAPTER 2: Site characteristics

- 2.1. Geography and demography
- 2.2. Evaluation of site specific hazards
- 2.3. Proximity of industrial, transportation and other facilities
- 2.4. Activities at the plant site that might influence the safety of the plant
- 2.5. Hydrology
- 2.6. Meteorology
- 2.7. Geology, seismology and geotechnical engineering
- 2.8. Site characteristics and the potential effects of the nuclear power plant in the region
- 2.9. Radiological conditions due to external sources
- 2.10. Site related issues in emergency preparedness and response and accident management
- 2.11. Monitoring of site related parameters



SMR FEATURES

SMR key safety features

- Key features
 - Modularity and modularization
 - Extensive use of passive safety systems relying on natural forces (gravity)
 - Small footprint / transportable
- Other features related to reactor technologies
 - Different coolants than water
 - Higher fuel enrichment up to 20%
 - Different design solutions to ensure reactor shutdown
 - Remote location and remote operation
 - Potential deployment near urban areas



UPDATING IAEA SAFETY STANDARDS

10

Requirements and Safety guides	Year	2025				2026				2027				2028				2029				2030				2031				2032				2033				2034				2035			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4								
SSR-2/1 (Rev.1) Design requirements	2016		1	2	3	4	4	5	5	5	5	5	5	6	7	7	8	8	8	8	9, 10	11	12	12	13	14																			
SSG-30 Safety Classification of SSCs	2014						1	2	3	4	4	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14																				
SSG-34 Electrical systems	2016								1	2	3	4	4	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14																	
SSG-38 Construction of NPPs	2015												1	2	3	4	4	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14													
SSG-39 Instrumentation and control	2016								1	2	3	4	4	5	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14																
SSG-51 Human Factors Engineering	2019												1	2	3	4	4	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14													
SSG-52 Reactor core design	2019						1	2	3	4	4	5	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14																		
SSG-53 Reactor containment	2019						1	2	3	4	4	5	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14																		
SSG-56 Reactor coolant	2020						1	2	3	4	4	5	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14																		
SSG-62 Auxiliary systems	2020													1	2	3	4	4	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14													
SSG-63 Fuel handling and storage	2020										1	2	3	4	4	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14															
SSG-64 (Internal hazards	2021														1	2	3	4	4	5	5	5	6	7	7	8	8	9, 10	11	12	12	14													
SSG-69 Equipment qualification	2021																	1	2	3	4	4	5	6	7	7	8	8	9, 10	11	12	12	14												
SSG-88 Practical elimination	2024																				1	2	3	4	4	5	5	6	7	7	8	8	9, 10	11	12	12	14								
SSG-90 Radiation protection	2024																				1	2	3	4	4	5	5	6	7	7	8	8	9, 10	11	12	12	14								
SSG-61 Safety Analysis report	2021																				1	2	3	4	4	5	5	6	7	7	8	8	9, 10	11	12	12	14								
GSR Part 4 (Rev.1) Safety assessment	2016						1	2	3	4	4	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	13	14																			
SSG-2 (Rev.1) Deterministic safety analysis	2019												1	2	3	4	4	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14														
SSG-3 (Rev.1) Level 1 PSA	2024																																												
SSG-4 (Rev.1) Level 2 PSA	2025	12	12	14																									1	2	3	4	4	5	5	5	5	6	7	7					
SSG-X (L3PSA) Level 3 PSA	New	2	3	4	4	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14																									
SSG-X (DS537) Safety demonstration	New	7	8	9, 10	9, 10	11	12	14																																					
SSG-25 (Rev.1) Periodic safety review	2013	7	7	8	9, 10	9, 10	11	11	12	12	14																																		
SSG-54 Accident management	2019												1	2	3	4	4	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	14														
SSR-XX (New safety requirements Fusion)	New								1	2	3	4	4	5	5	5	5	5	6	7	7	8	8	9, 10	11	12	12	13	14																



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THANK YOU