



IAEA

International Atomic Energy Agency
Atoms for Peace and Development

Applicability of IAEA Safety Standards related to Safety Assessment to Advanced Small Reactor Designs

First Meeting of the IAEA TWG on SMRs
IAEA HQs, Vienna, 22-26 April, 2018 – M5

Palmiro Villalibre

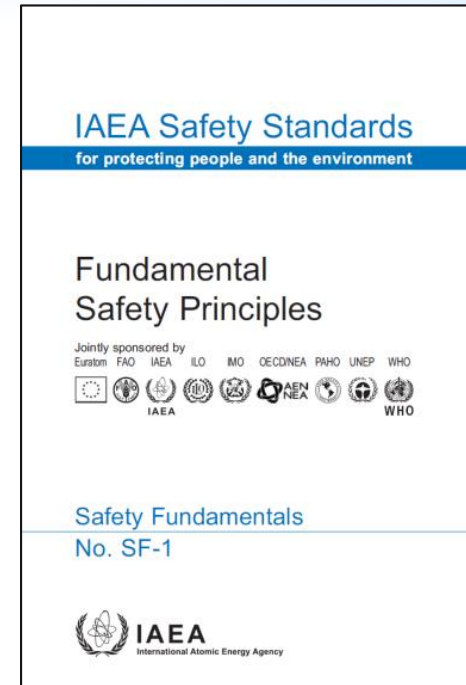
Safety Assessment Section (SAS)

Division of Nuclear Installation Safety (NSNI)

Department of Nuclear Safety and Security (NS)

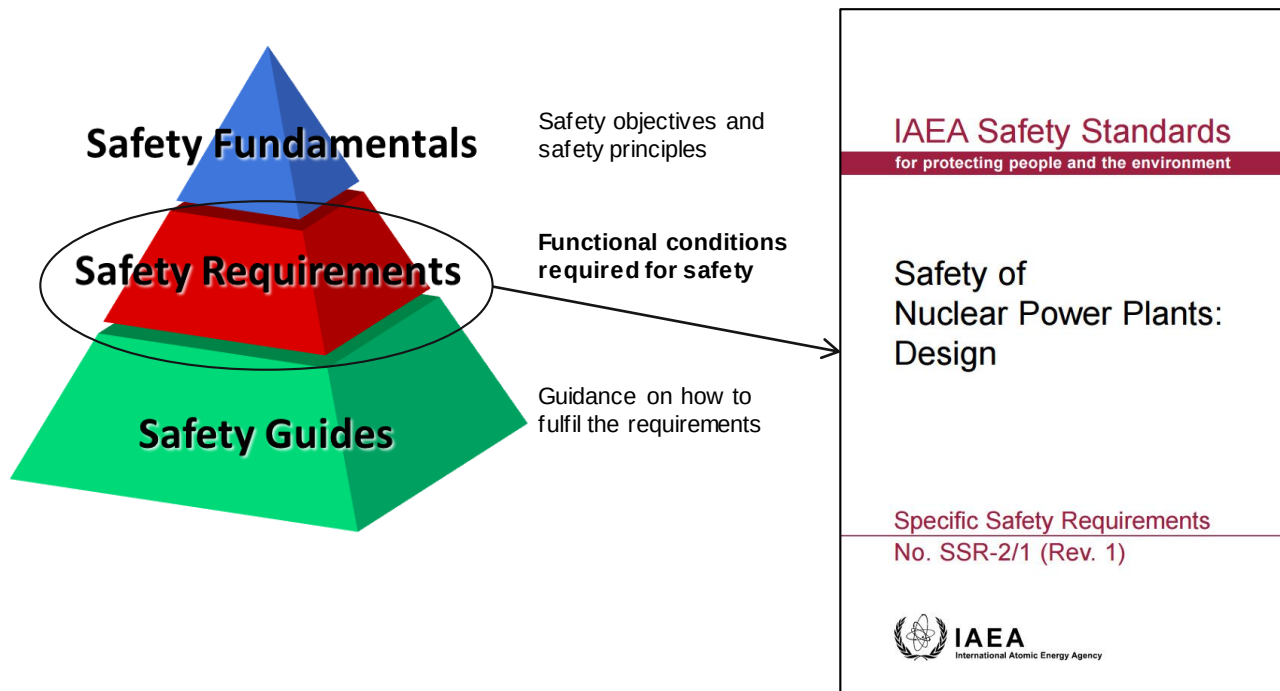
- IAEA Safety Standards
 - Hierarchy, structure, applicability, preparation/review
 - Safety Guides under review
- Applicability of Safety Standards to SMRs
 - Available documents (Tecdoks)
 - Light Water Reactors
 - High Temperature Gas-cooled Reactors
 - Planned reports
 - Project Report from the study
 - Technical Document on safety approach
 - Safety Report on safety assessment
- Support to embarking countries
 - TC Project RER2014 (Europe)

Safety Standards Hierarchy



Global Reference
Point for a High Level
of Nuclear Safety

Design Safety Requirements



- To be implemented by the **designer** to fulfill the fundamental safety functions with the appropriate level of defence in depth
- To be used by the reviewer (e.g. **Regulatory Body**) to assess the safety of the design

Safety Standards Structure

Safety Fundamentals Fundamental Safety Principles

General Safety Requirements

Part 1. Governmental, Legal and
Regulatory Framework for Safety

Part 2. Leadership and Management for Safety

Part 3. Radiation Protection and
Safety of Radiation Sources

**Part 4. Safety Assessment for
Facilities and Activities**

Part 5. Predisposal Management
of Radioactive Waste

Part 6. Decommissioning and
Termination of Activities

Part 7. Emergency Preparedness
and Response

Specific Safety Requirements

1. Site Evaluation for Nuclear Installations

2. Safety of Nuclear Power Plants
2.1 Design
2.2 Commissioning and Operation

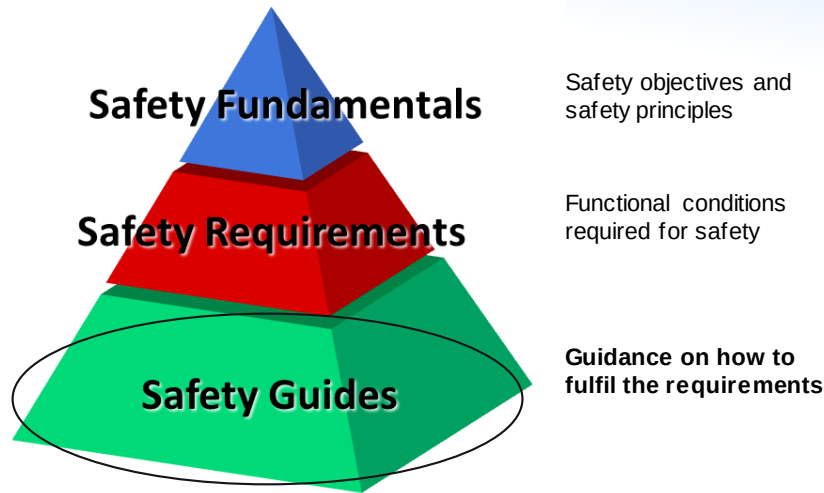
3. Safety of Research Reactors

4. Safety of Nuclear Fuel Cycle Facilities

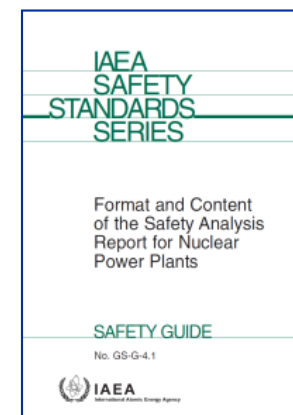
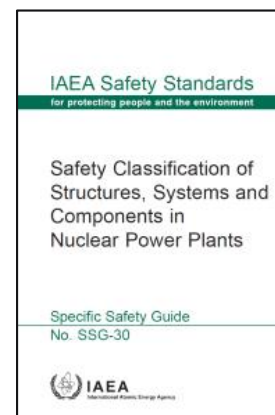
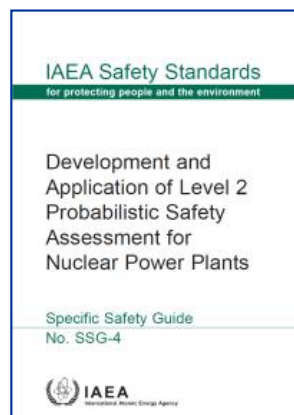
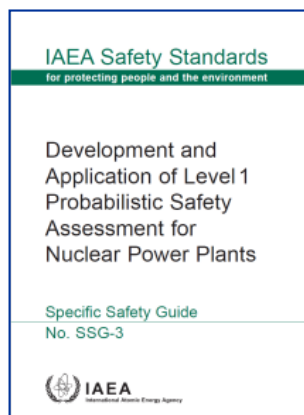
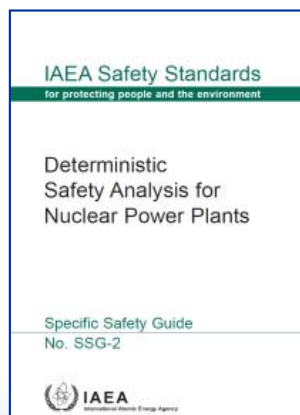
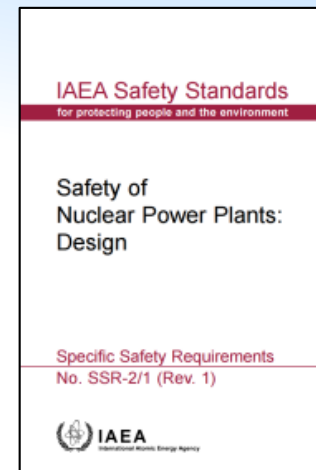
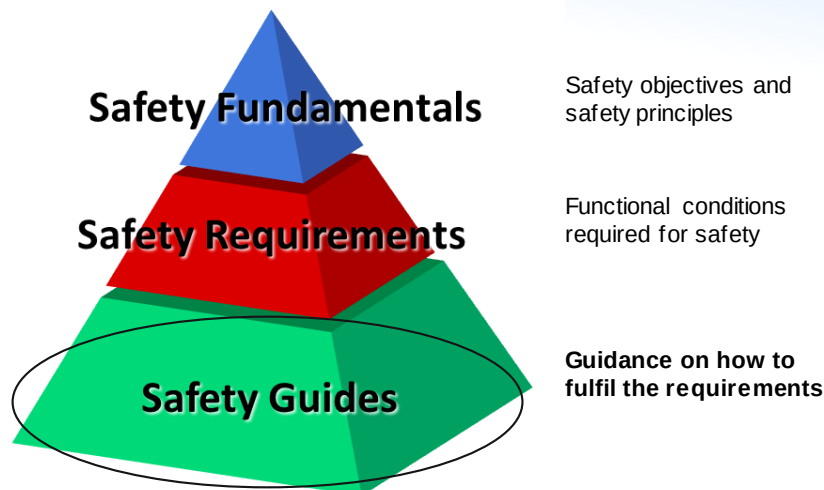
5. Safety of Radioactive Waste Disposal
Facilities

6. Safe Transport of Nuclear Material

Safety Guides on Design



Other Safety Guides



- New Nuclear Power Plants
 - Primarily to NPPs with water cooled reactors (land based stationary)
- Other reactor types
 - With judgement to determine how the requirements have to be considered in developing the design
- Nuclear Power Plants in operation
 - It might not be practicable to entirely apply
 - Expected: comparison made against current standards, for example as part of the periodic safety review

Considerations on Application

IAEA TECDOC SERIES



IAEA-TECDOC-1791

Considerations on the
Application of the
IAEA Safety Requirements
for the Design of
Nuclear Power Plants

AIMED AT

- facilitating the understanding
- providing more explicit information

ON

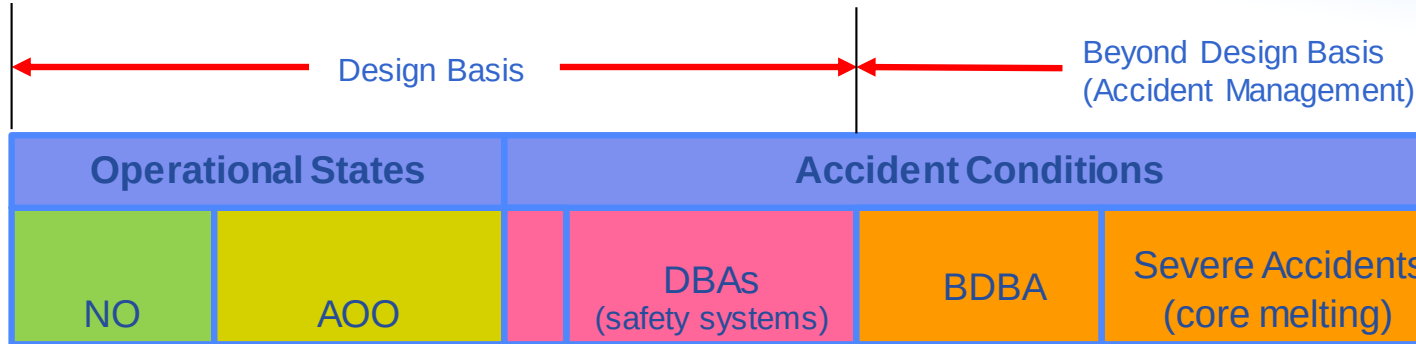
- selected new topics and terms introduced

WHERE

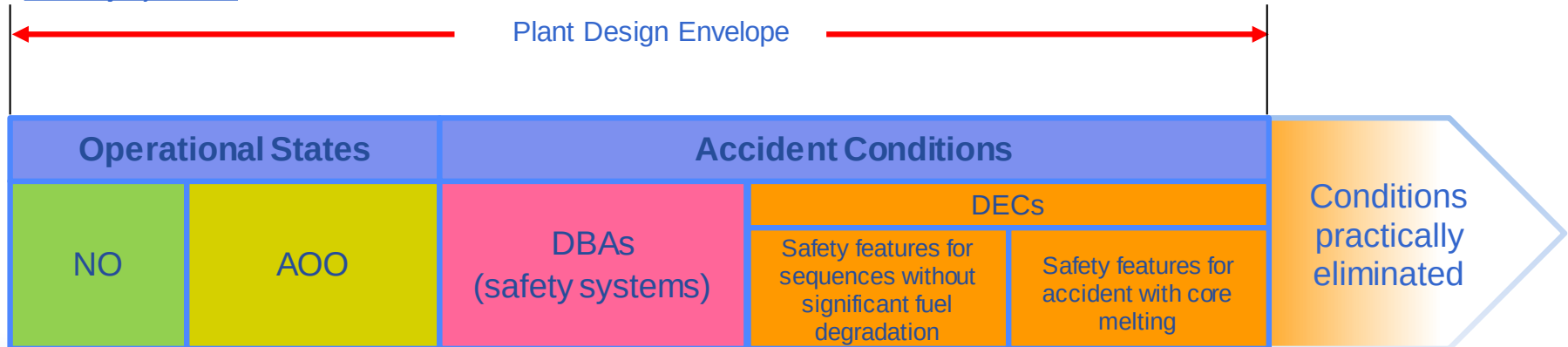
- not always a common understanding in MSs

New Design Safety Principles

Earlier Concept



SSR-2/1, 2012



Review of Safety Standards

Commission and Committees

Commission on Safety Standards (CSS)

**Nuclear
Safety
Standards
Committee
(NUSSC)**

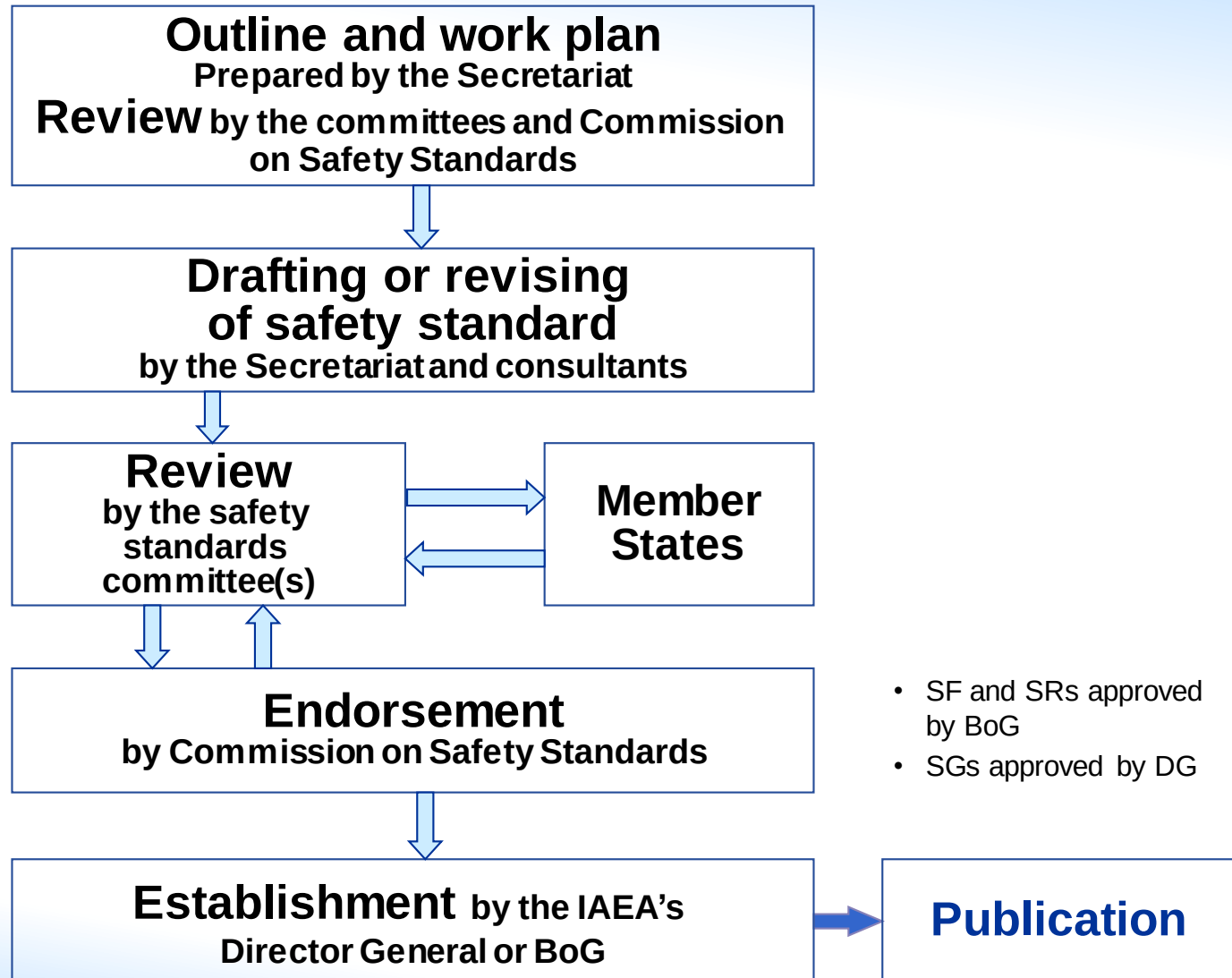
**Radiation
Safety
Standards
Committee
(RASSC)**

**Waste
Safety
Standards
Committee
(WASSC)**

**Transport
Safety
Standards
Committee
(TRANSSC)**

**Emergency
Preparedness
Safety
Standards
Committee
(EPRReSC)**

Process Flow for the Development



Involvement of Stakeholders



Participation by the different stakeholders (for example, regulators, operators, designer and TSOs) during the **drafting and review phase** is a long established practice

Review of Safety Standards

- **Fukushima Daiichi Action Plan**
 - **General Safety Requirements (2016)**
 - **Specific Safety Requirements (2016)**
 - Safety Guides (related to safety assessment)
 - Currently in process (advanced status)

[Review of safety requirements and Safety Guides
8-9 years]

Safety Guides under review



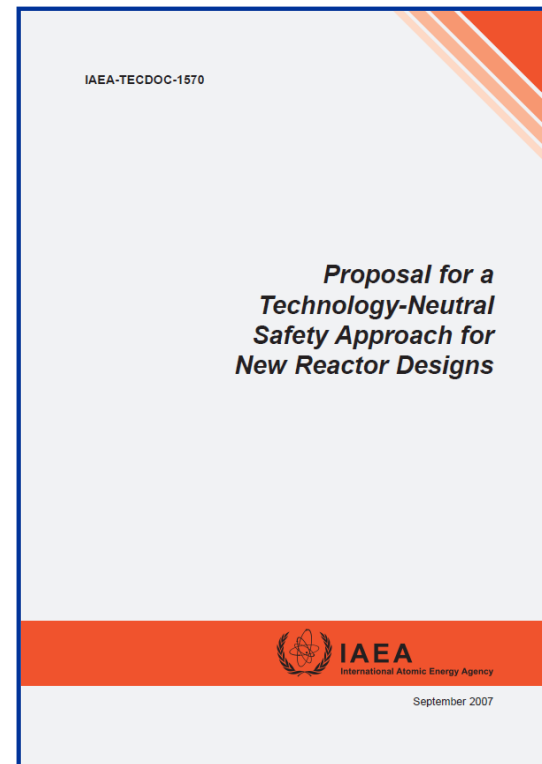
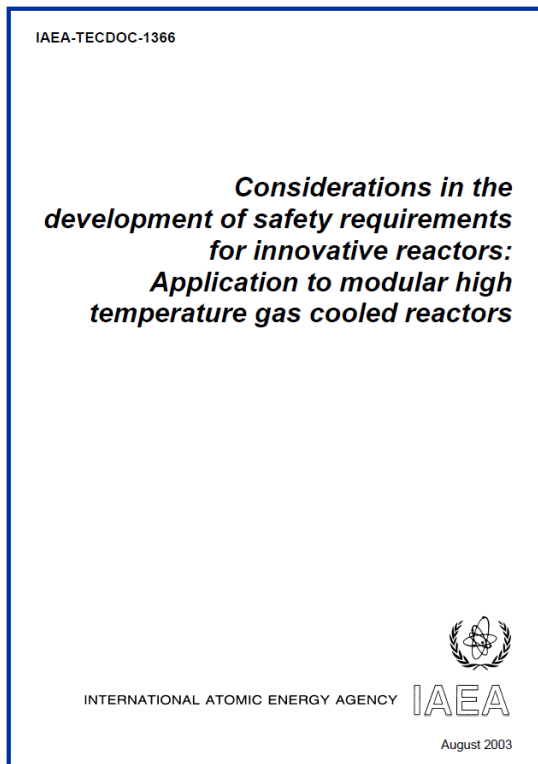
- Design of the Reactor Coolant System and Associated Systems in NPPs (*NS-G-1.9^(*)*)
- Design of Reactor Containment Systems for NPPs (*NS-G-1.10^(*)*)
- Severe Accident Management Programmes for NPPs (*N-SG 2.15^(*)*)
- Protection against Internal Hazards in the Design of Nuclear Power Plants (*Revision of NS-G-1.7^(*) and NS-G-1.11^(*)*)
- Design of Fuel Handling & Storage Systems for NPPs (*NS-G-1.4^(*)*)
- Design of the Reactor Core for NPPs (*NS-G-1.12^(*)*)
- Human Factors Engineering in NPPs (*new, DS492*)
- Design of Auxiliary and Supporting Systems for NPPs (*new, DS440*)
- Deterministic Safety Analysis for NPPs (*SSG-2^(*)*)
- Format and Content of the Safety Analysis Report for NPPs (*GS-G-4.1^(*)*)

() Former Safety Guide that will be superseded*

Applicability of Safety Standards to Advanced Small Reactors (Other Technologies)

Technical documents

- IAEA TECDOC 1366 – published in 2003
- IAEA TECDOC 1570 – published in 2007

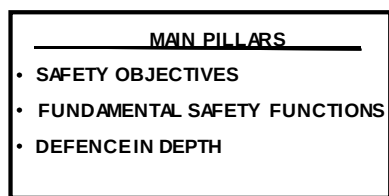


Key Issues Addressed

- Suitability of classical safety approach to innovative reactor designs
- Logical Framework to develop national safety requirements
 - More *risk-informed*, less prescriptive
 - Based on safety requirements established for LWRs
 - Systematic evaluation of DiD implementation
- Systematic, logical and auditable design process
- Review of consistency with existing national safety framework

Approach described

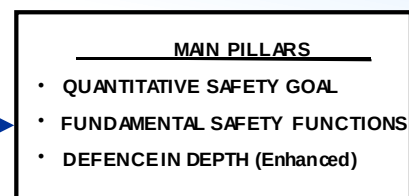
DESIGN AND LICENSING RULES FOR WATER-COOLED REACTORS



NEW APPROACH

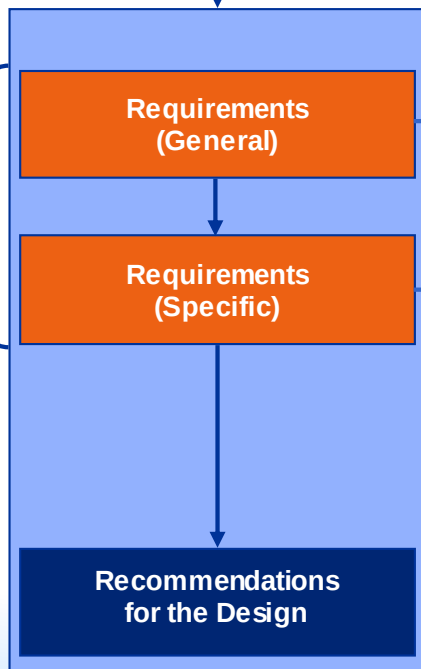
- MORE "RISK" INFORMED
- LESS PRESCRIPTIVE

DESIGN AND LICENSING RULES FOR A GIVEN INNOVATIVE DESIGN



Technology neutral

Safety Requirements

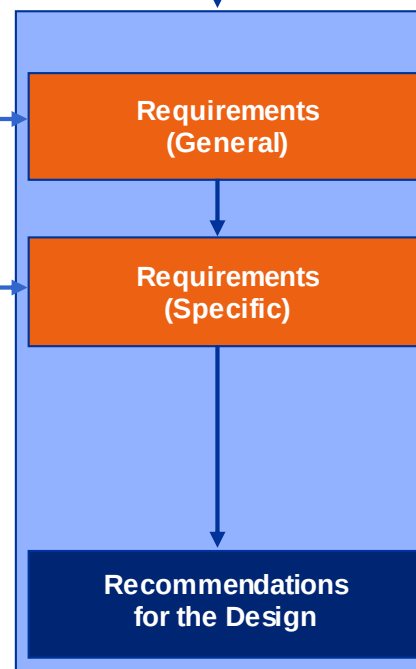


CRITICAL REVIEW

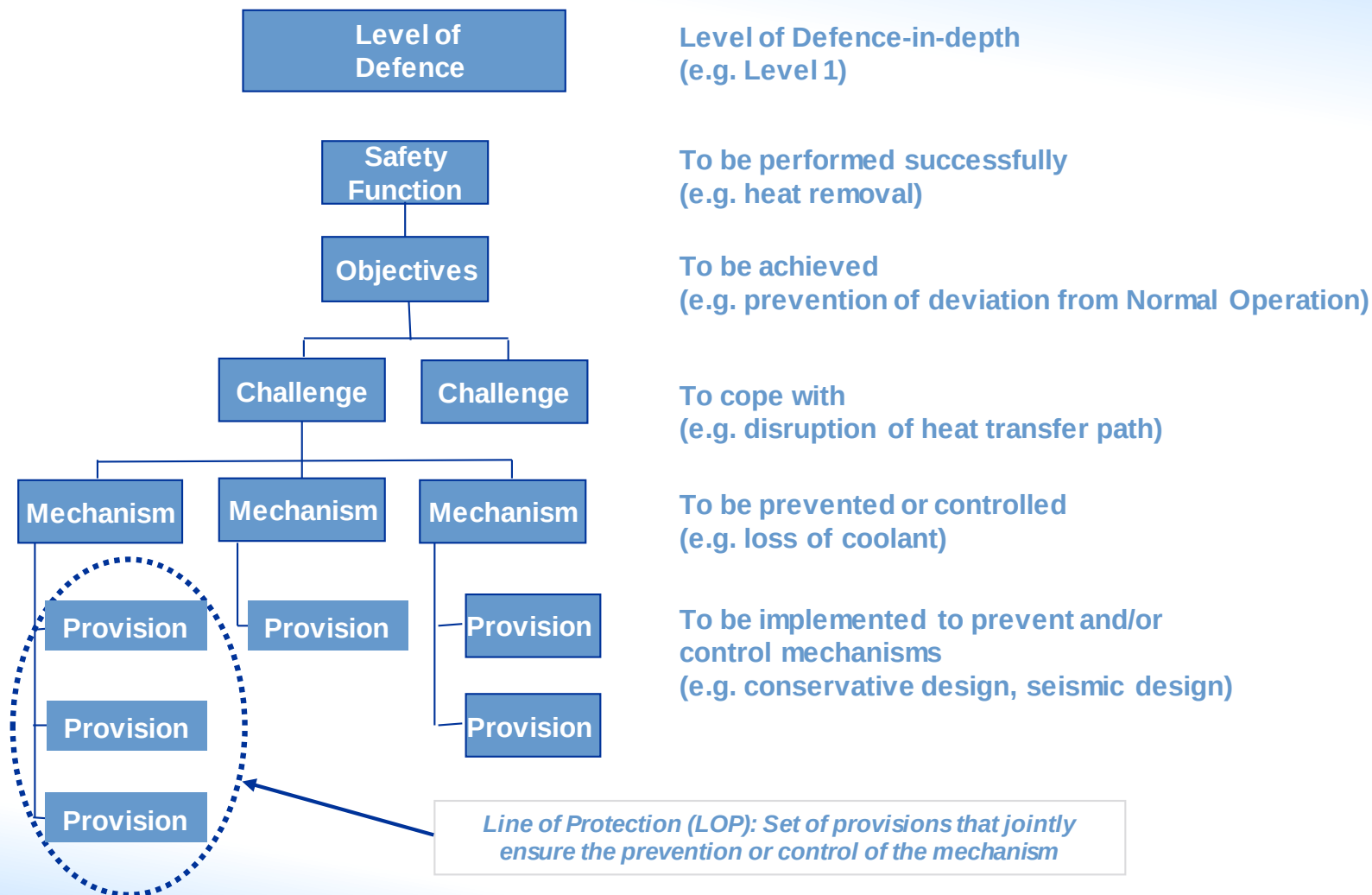
- 1) Understanding:
 - the rationale behind each requirement
 - the contribution of each requirement to defence in depth
 - whether the requirement is technology-neutral or technology-dependent
- 2) Application of an Objective-ProvisionsTree

Technology dependent

Safety Guides



Objective – Provisions Tree



Study on Applicability (1/2)

- Review of current practices on applicability of IAEA Design Safety Requirements, SSR-2/1 (Rev.1), to SMRs (2017)
- 14 organizations from 8 Member States:
 - BWXT, CGNPC, CNEA, CNNC, Holtec, IRSN, NET, JAEA, KAERI, NuScale, Steenkampshraal Thorium, Limited, Rolls-Royce, Westinghouse, X-Energy
- SMR Regulators' Forum representatives

Study on Applicability (2/2)

- Evaluation of all 82 Design Safety Requirements
 - Applicable as is
 - Applicable with interpretation
 - No modification is required
 - Rationale for the application of the requirement is different than that of the standard light water reactor
 - Application with modification
 - Modifications are required to be applicable
 - New criteria // - Not applicable
- Applied to LWRs and HTGcRs
- Outcome: Project Report, not publically available

Planned reports

Project Report

- Study on the applicability of the IAEA Design Safety Requirements, SSR-2/1 (Rev.1), to SMRs
 - Completion of considerations for SMR-HTGRs
 - Consultancy Meeting planned 2-6 July 2018
 - Completion of Project Report (planned 4Q-2018)
 - Potential additional Consultancy Meeting in 4Q
 - Final wording and harmonization (LWR, HTGRs)

Technical Document

- General safety approach
 - Application of logical framework to establish national safety requirements
- Utilization of insights obtained from the study (SMR-LWRs and SMR-HTGRs)
- Objective: exemplary development of safety requirements for SMR technologies
 - IAEA document (i.e., publically available)
- Assistance to MSs on their own application, if so wished

Safety Report

- Broaden scope to comprehensively address safety aspects of SMRs (near term deployment)
 - Defense-in-depth
 - Safety margins
 - Acceptance criteria
 - Safety barriers
 - Deterministic Safety Analysis
 - Probabilistic Safety Analysis
 - Safety Analysis Report
 - Examples in Annexes

TC Project RER2014 (Europe)



Facilitating Capacity Building for Small Modular Reactors: Technology Developments, Safety Assessment, Licensing and Utilization

- Potential participants: European countries recipient of TC Program
- Planned workshops (Safety)
 - Licensing and regulatory framework for SMR deployment
 - Site evaluation and protection against external hazards
 - Design safety and safety assessment for SMRs
 - Emergency preparedness and response for SMRs deployment



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Thank you!

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