Training Course
on the IAEA Safety Standards Overview

IAEA General Safety Requirements GSR Part 4 (Rev.1) Safety Assessment for Facilities and Activities

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Outline

- INTRODUCTION
- REV.1 OF IAEA REQUIEMENTS ON SAFETY ASSESSMENT
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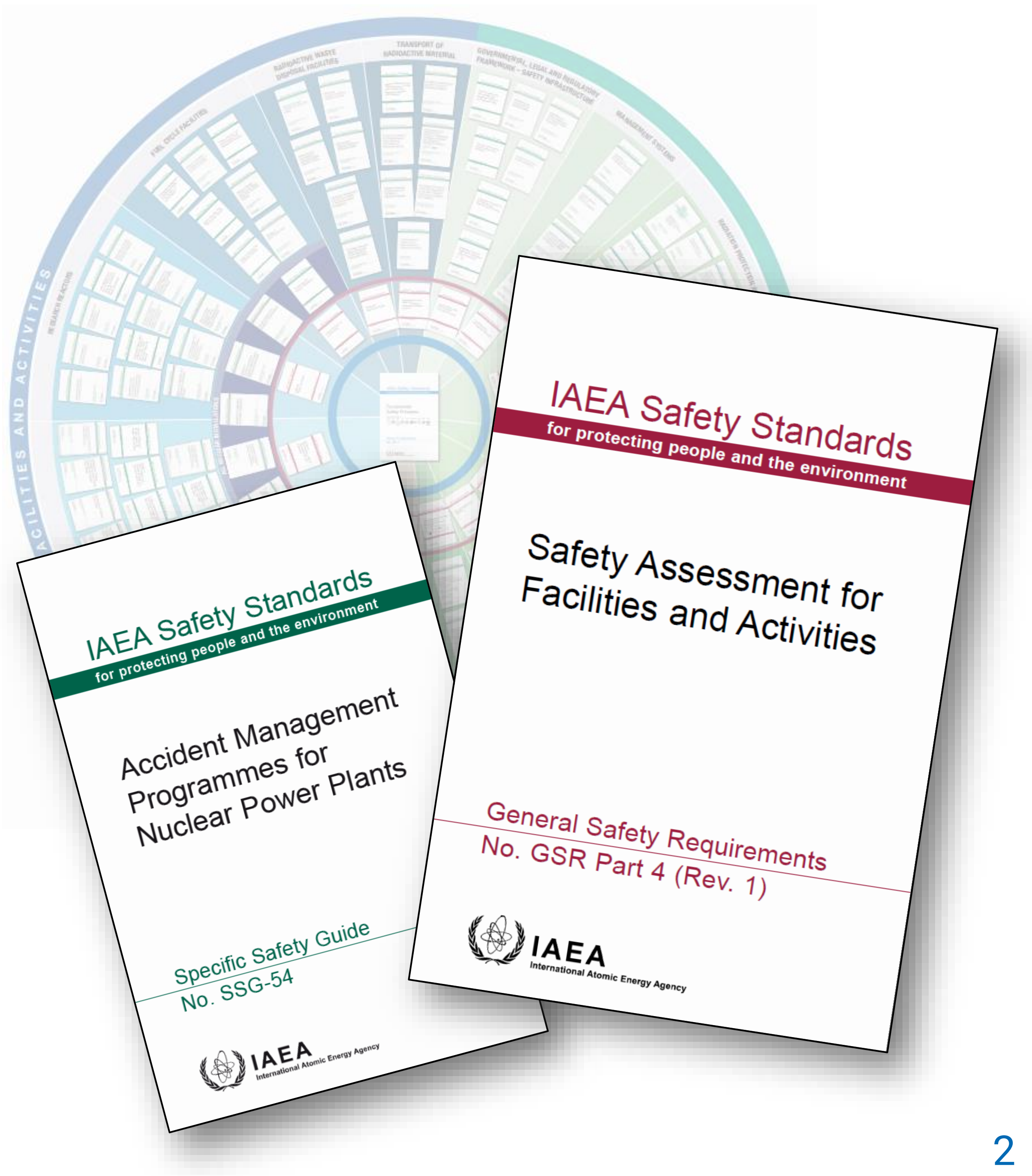
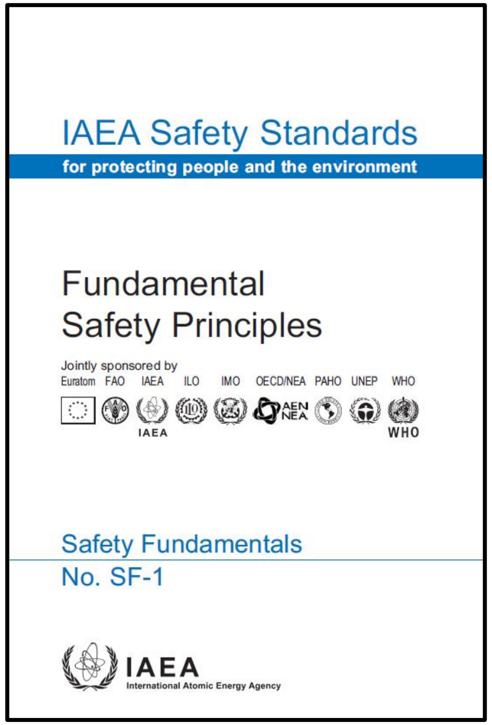
  - SAFETY ASSESSMENT
  - MANAGEMENT, USE AND MAINTENANCE OF SAFETY ASSESSMENT
- IAEA SAFETY GUIDE ON ACCIDENT MANAGEMENT
- CONCLUSIONS



Introduction

INTRODUCTION



Safety shall be assessed for all facilities and activities consistent with a graded approach

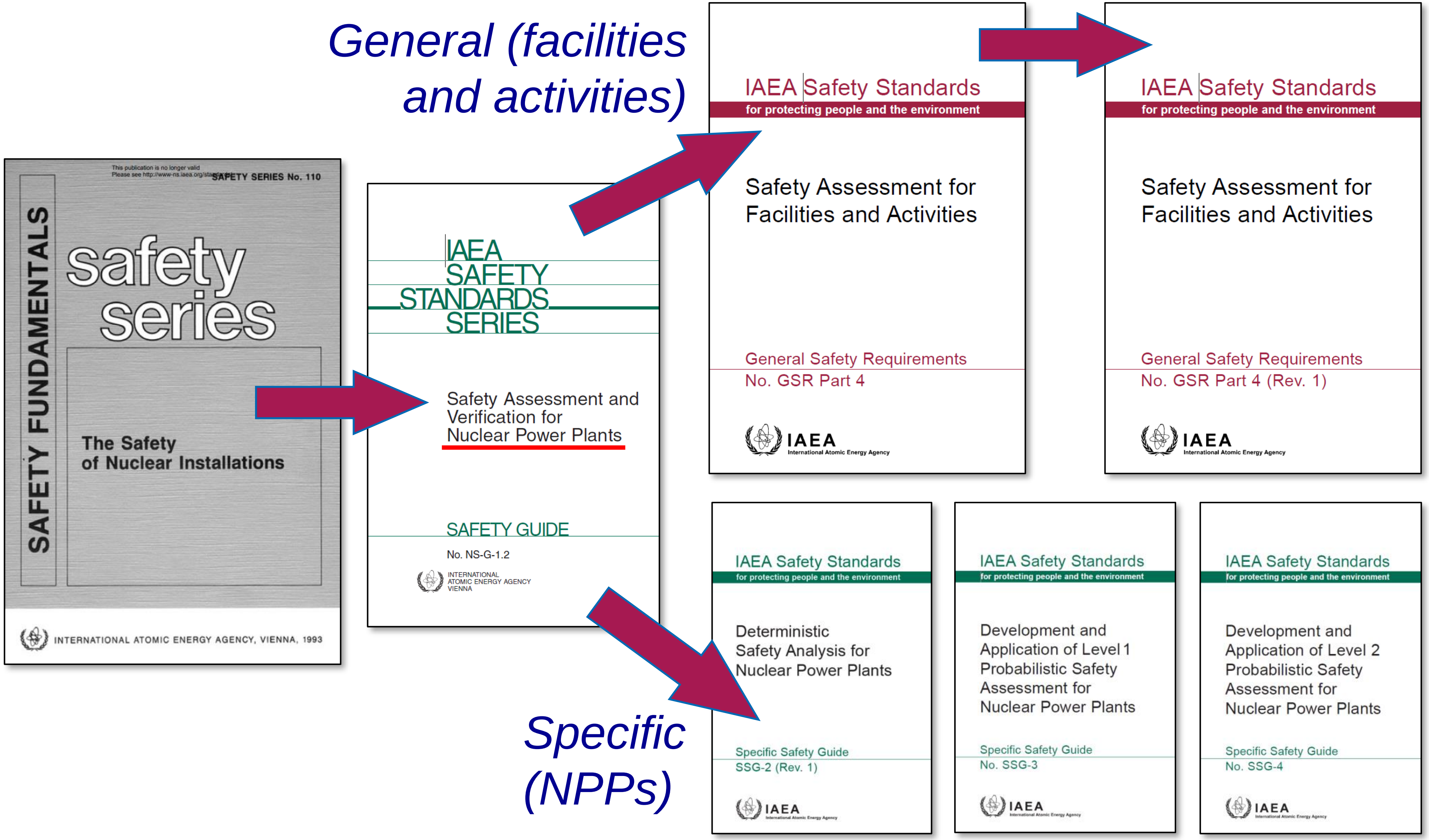
Facility/activity may only be commissioned or commenced **once it has been demonstrated to the satisfaction of the regulatory body** that the proposed safety measures are adequate.

Safety assessment is **repeated in whole or in part** as necessary in order to take into account changed circumstances

- application of new standards
- technological developments,
- feedback of operating experience
- modifications and the effects of ageing

Continuation of such operations is subject to demonstrating to the satisfaction of the regulatory body that the **safety measures remain adequate.**

IAEA Requirements for Safety Assessment



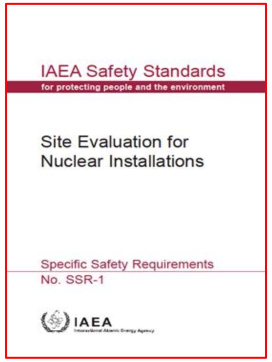
Facilities:
NPPs, research reactors, critical assemblies, fuel cycle facilities, irradiation facilities, etc.

Activities:
Production, use, import and export of radiation sources, transport of radioactive material, mining, decommissioning and dismantling of facilities, etc.

■ ■ ■ ■ ■ ■ ■

Requirements in relation to Safety Assessment referred from:

- **SSR-1 Site Evaluation for Nuclear Installations**
- **SSR-2/1 (Rev. 1) Safety of Nuclear Power Plants: Design**
- **SSR-2/2 (Rev. 1) Safety of Nuclear Power Plants: Commissioning and Operation**
  - **Operation**
  - **Plant Modifications**
  - **Maintenance, testing, surveillance and inspection programmes**
  - **Periodic safety review and long-term operation**
- **SSR- 3 Safety of Research Reactors**
- **SSR-4 Safety of Nuclear Fuel Cycle Facilities**


IAEA Safety Standards
for protecting people and the environment
Site Evaluation for Nuclear Installations
Specific Safety Requirements
No. SSR-1
IAEA


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


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)
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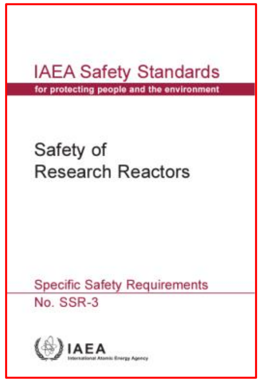

IAEA Safety Standards
for protecting people and the environment
Safety of Research Reactors
Specific Safety Requirements
No. SSR-3
IAEA


IAEA Safety Standards
for protecting people and the environment
Safety of Nuclear Fuel Cycle Facilities
Specific Safety Requirements
No. SSR-4
IAEA

IAEA Safety Standards on Safety Assessment

General Safety Requirements are addressed in GSR Part 4 (facilities and activities – F&A)

NPP details in safety guides

- SSG-2 (Rev. 1) (DSA)
- SSG-3 (Rev. 1) and SSG-4 (Rev. 1) (PSA)
- SSG-61 (SAR)

Safety Approach

- Acceptance criteria/design limits
- Defense in Depth (DiD) and plant states
- Requirements for reliability

IAEA

IAEA GSR Part 4 (Rev.1) Safety Assessment for Facilities and Activities

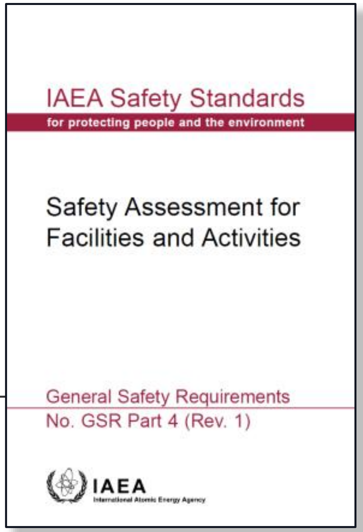
IAEA Safety Standards on Safety Assessment

Requirements for conducting the safety assessment are defined in the General Safety Requirements (GRS Part 4 (Rev.1), 2016)

Revised after the Fukushima Daiichi nuclear accident. The changes introduce reinforcements related to:

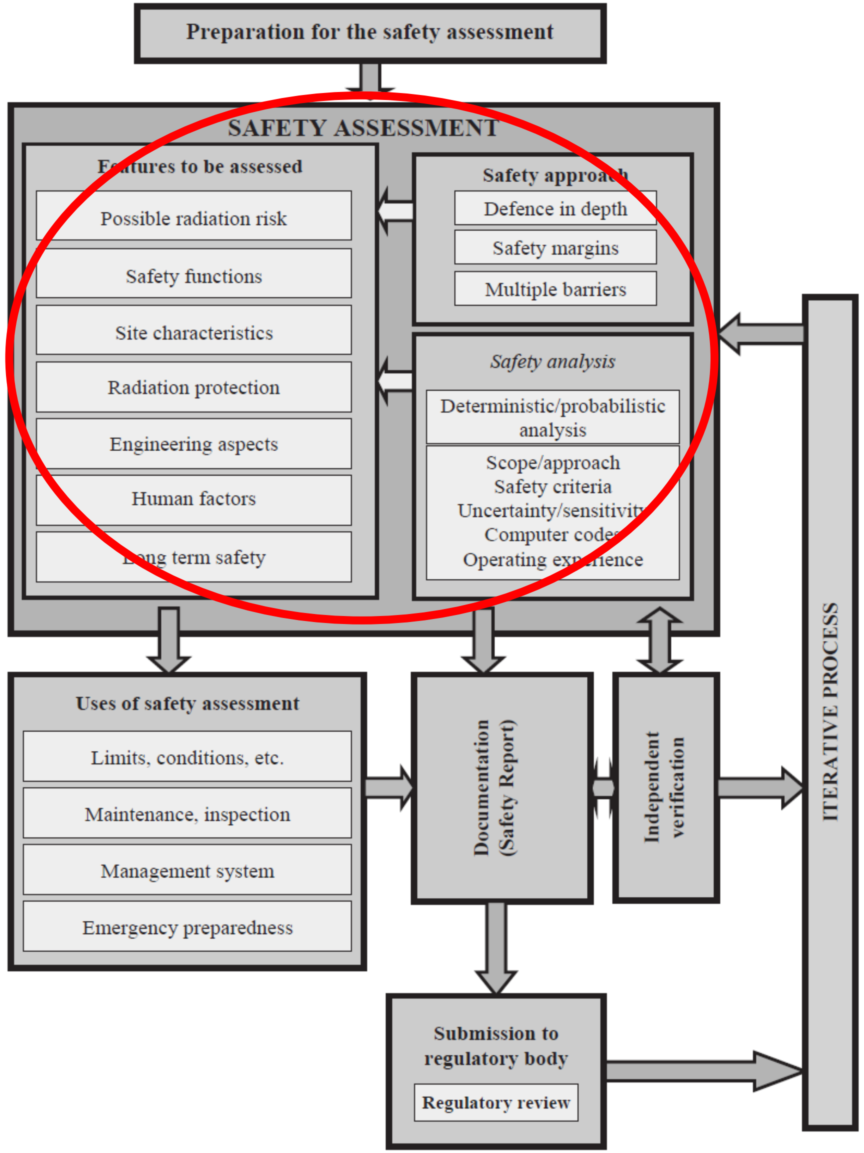
- Margins to withstand external events
- Margin to avoid cliff-edge effects
- Multiple facilities/activities at one site
- Cases where resources are shared
- Human factors in accident conditions

CONTENTS



IAEA Safety Standards on Safety Assessment

- Is the systematic process that is carried out throughout the lifetime of the facility or activity to ensure that all the relevant safety requirements are met by the proposed or actual design.
- For an authorized facility, it includes siting, design and operation of the facility.
- **Safety assessment includes**, but is not limited to, **the formal safety analysis.**



Assembling the expertise, tools and information required to carry out the work

Identification of the possible radiation risks in different plant states

Identification and assessment of a **comprehensive set of SF**

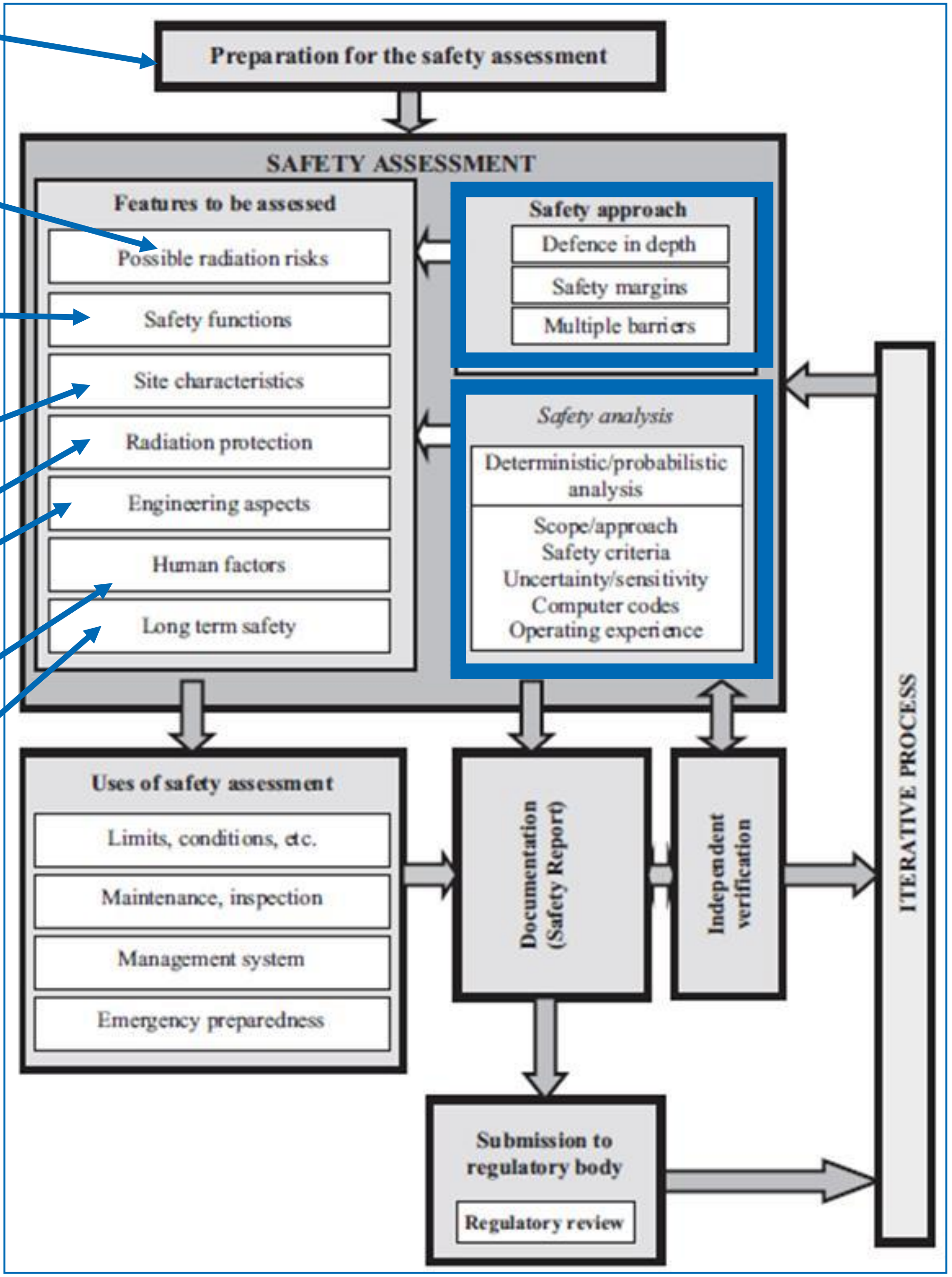
Assessment of the **site characteristics** that relate to the possible radiation risks

Assessment of the provisions for **radiological protection**

To determine whether the **safety requirements** are met

Human factor related aspects of the design and operation

Assessment of **safety in the longer term** (ageing effects might develop and might affect safety margins, decommissioning and closure of repositories for radioactive waste)



SAFETY ASSESSMENT: Requirement 1

Req. 1

GRADED APPROACH

A graded approach shall be used in determining the scope and **level of detail** of the safety assessment carried out in a particular State **for any particular facility or activity**, consistent with the **magnitude of the potential radiation risks** arising from the facility or activity

- Allows flexibility in the way that the possible radiation risks are assessed and controlled **without unduly limiting the operation.**

- **Graded approach used to determine:**
  - scope and level of detail
  - resources to be directed

- **Graded approach considers:**
  - magnitude of the possible risks
  - risks at all plant states
  - very low probability events with potentially high consequences
  - maturity or complexity of facility or activity

SAFETY ASSESSMENT: Requirement 1 (cont'd)

Req. 1

GRADED APPROACH

A graded approach shall be used in determining the scope and **level of detail** of the safety assessment carried out in a particular State **for any particular facility or activity**, consistent with the **magnitude of the potential radiation risks** arising from the facility or activity

- **Maturity**
  - proven practices, procedures and designs
  - data on performance of F&A
  - uncertainties in the performance of F&A
  - continuing and future availability of experienced manufacturers and constructors.
- **Complexity**
  - efforts required to construct or do the F&A
  - processes for which control is necessary
  - radioactive material handling extent
  - longevity of the radioactive material
  - reliability and complexity of structures, systems and components (SSC)
  - accessibility of SSC for maintenance inspection, testing and repair

SAFETY ASSESSMENT: Requirement 1 (cont'd)

Req. 1

GRADED APPROACH

A graded approach shall be used in determining the scope and **level of detail** of the safety assessment carried out in a particular State **for any particular facility or activity**, consistent with the **magnitude of the potential radiation risks** arising from the facility or activity

- **The application of the graded approach shall be reassessed** as the safety assessment progresses and a better understanding is obtained of the radiation risks arising from the facility or activity.
- The scope, level of detail and level of resources then **modified as necessary**
- Graded approach shall also be taken in **when updating the safety assessment.**

SAFETY ASSESSMENT: Requirement 2

Req. 2

SCOPE OF SAFETY ASSESSMENT

A safety assessment shall be carried out for **all applications of technology** that give rise to radiation risks — that is, for all types of facilities and activities

Facilities:

- NPPs, research reactors, critical assemblies, fuel cycle facilities, irradiation facilities, etc.

Activities:

- Production, use, import and export of radiation sources, transport of radioactive material, mining, decommissioning and dismantling of facilities, etc.

SAFETY ASSESSMENT: Requirement 3

Req. 3

RESPONSIBILITY FOR SAFETY ASSESSMENT

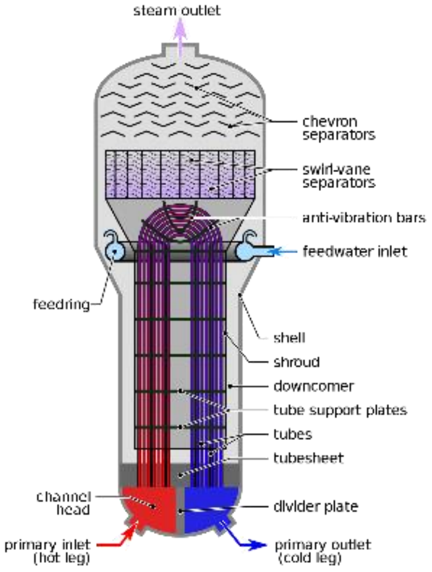
The responsibility for carrying out the safety assessment shall rest with the **responsible legal person**, i.e. the person or organization responsible for the facility or activity.

IAEA Fundamental Safety Principles

*“The **licensee** retains the **prime responsibility** for safety throughout the lifetime of facilities and activities, and this responsibility **cannot be delegated**.”*

SAFETY ASSESSMENT: Requirement 3 (cont'd)

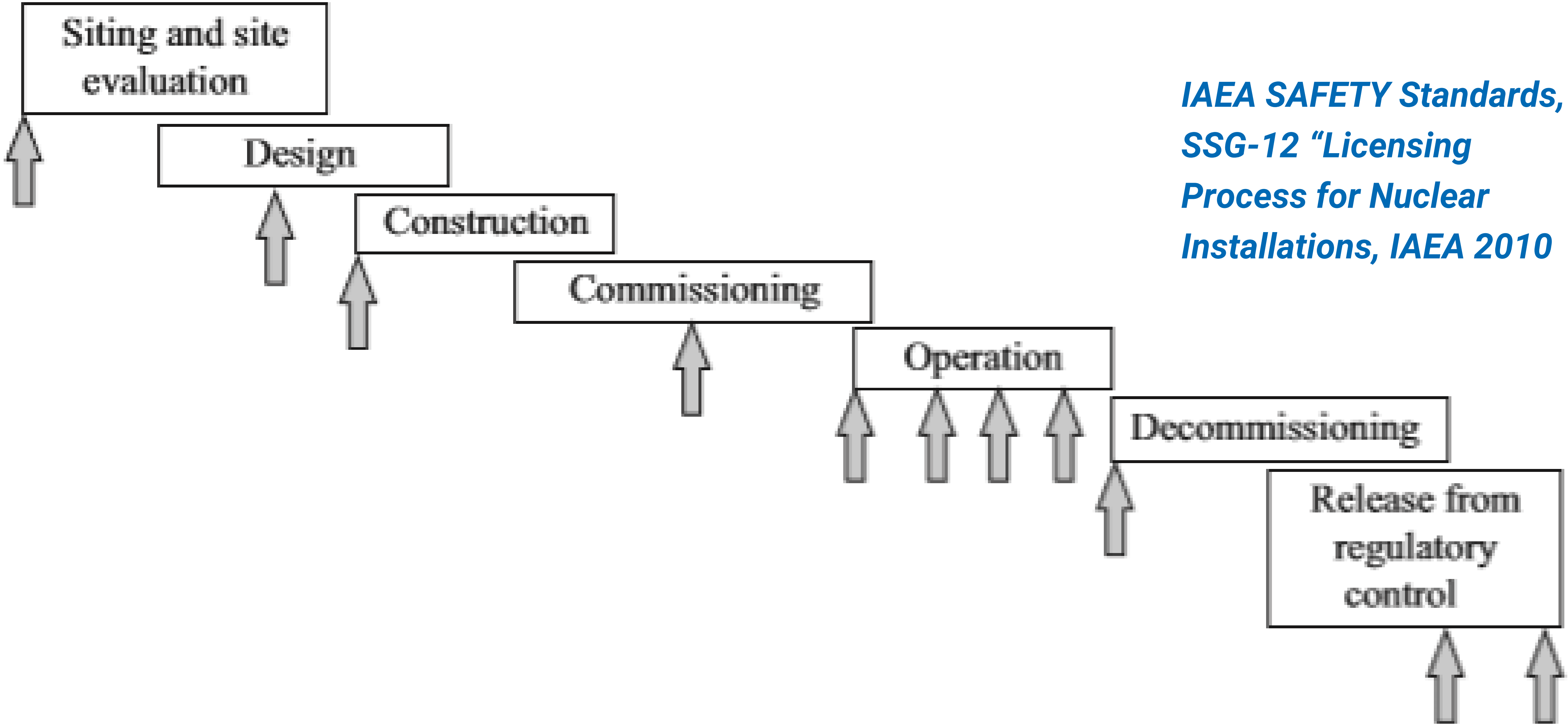
Other groups, such as **designers, manufacturers, constructors, employers, contractors, consignors** and **carriers**, also have legal, professional or functional responsibilities with regard to safety.



The **regulatory body** shall review and assess submissions on safety from the operators both prior to authorization and periodically during operation as required.

SF-1: Facility/activity may only be commissioned or commenced ***once it has been demonstrated to the satisfaction of the regulatory body***

Lifetime stage of nuclear installation (hold points)



IAEA SAFETY Standards, SSG-12 "Licensing Process for Nuclear Installations, IAEA 2010

FIG 1. Stages in the lifetime of a nuclear installation; the arrows indicate where hold points may be imposed.

SAFETY ASSESSMENT: Requirement 4

Req. 4

PURPOSE OF THE SAFETY ASSESSMENT

The primary purposes of the safety assessment shall be:

- to determine whether an **adequate level of safety** has been achieved for a facility or activity
- whether the basic **safety objectives and safety criteria** established by the designer, the operating organization and the regulatory body have been **fulfilled.**

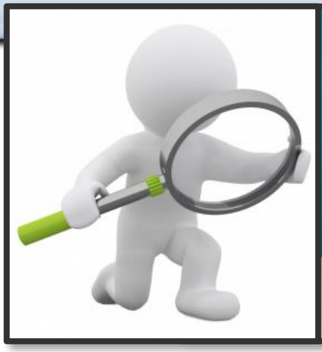
… in compliance with the requirements for radiation protection and safety as established in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources.

SAFETY ASSESSMENT: Requirements 5-6

Req. 5

PREPARATION FOR THE SAFETY ASSESSMENT

The **first stage** of carrying out the safety assessment shall be to ensure that the **necessary resources, information, data, analytical tools** as well as **safety criteria** are **identified** and are **available**.



Req. 6

ASSESSMENT OF THE POTENTIAL RADIATION RISKS

The **possible radiation risks** associated with the facility or activity shall be **identified** and **assessed.**

SAFETY ASSESSMENT: Requirement 7

Req. 7

ASSESSMENT OF SAFETY FUNCTIONS

All **safety functions** associated with a facility or activity shall be **specified and assessed**

- **All safety functions** associated with a facility or activity shall be specified and assessed
- Includes the functions associated with **SSCs, barriers, inherent safety features, human actions**
- An assessment is undertaken to determine **whether the safety functions** can be fulfilled for all plant states (including normal operation)
- SA shall determine whether SSCs and barriers performing the safety functions have an adequate level of **reliability, redundancy, diversity, separation, segregation, independence and equipment qualification and whether potential vulnerabilities have been identified and eliminated.**

SAFETY ASSESSMENT: Requirement 8

Req. 8

ASSESSMENT OF SITE CHARACTERISTICS

An assessment of the **site characteristics** relating to the safety of the facility or activity shall be carried out

- **Evaluation of the site characteristics shall cover:**
  - Physical, chemical, radiological characteristics that will affect the dispersion or migration of radioactive material
  - Identification of natural and human induced events
  - Distribution of the population around the site.
- **Scope and level of detail** of the site assessment shall be consistent with the possible radiation risks associated with the facility or activity, the type of facility to be operated or activity to be conducted, and the purpose of the assessment
- The site assessment **shall be reviewed periodically** over the lifetime of the facility or activity

? **Which site characteristics would you expect to change and how are they relevant to safety assessment?**

SAFETY ASSESSMENT: Requirements 9-10

Req. 9

ASSESSMENT OF THE PROVISIONS FOR RADIATION PROTECTION

It shall be determined in the safety assessment for a facility or activity whether **adequate measures** are in place to protect **people and the environment** from harmful effects of ionizing radiation

Req. 10

ASSESSMENT OF ENGINEERING ASPECTS

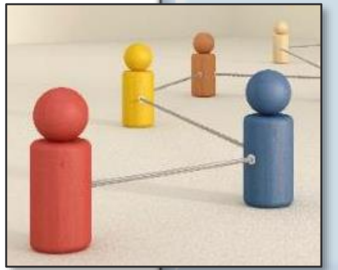
It shall be determined in the safety assessment whether a facility or activity uses, to the extent reasonable, **structures**, **systems** and **components** of **robust and proven design**

SAFETY ASSESSMENT: Requirement 11

Req. 11

ASSESSMENT OF HUMAN FACTORS

Human interactions with the facility or activity shall be **addressed** in the safety assessment and it shall be determined whether **the procedures and safety measures** that are **provided** for all **normal operational activities**, in particular those that are necessary for implementation of the operational limits and conditions, and those that are required in response to anticipated operational occurrences and accidents, ensure an **adequate level of safety**



- **Human actions** (in all plant states) shall be assessed
- Whether personnel competences, training programmes and minimum staffing levels are adequate
- Whether human factors were addressed in the design (Human Machine Interface; HOF)
- Aspects of **safety culture** shall be included in the safety assessment as appropriate
    - *Challenging task, see Safety Report No.127 for considerations on Human and Organisational Factors (HOF)*

SAFETY ASSESSMENT: Requirement 12

Req. 12

ASSESSMENT OF SAFETY OVER THE LIFETIME OF A FACILITY OR ACTIVITY

The safety assessment shall cover **all the stages in the lifetime** of a facility or activity in which there are possible radiation risks

- Safety assessment shall cover all the **lifetime stages (including design)**.
- Safety assessment includes activities that are carried out **over a long period of time, (e.g. decommissioning, dismantling)**
- For **disposal facility for radioactive waste** in significant quantities, radiation risks shall be considered for the post-closure phase.
    - Radiation risks following closure of the disposal facility may arise from gradual processes, e.g. degradation of barriers

SAFETY ASSESSMENT: Requirement 13

Req. 13

ASSESSMENT OF DEFENCE IN DEPTH

It shall be determined in the assessment of defence in depth whether adequate provisions have been made at **each of the levels of defence in depth**

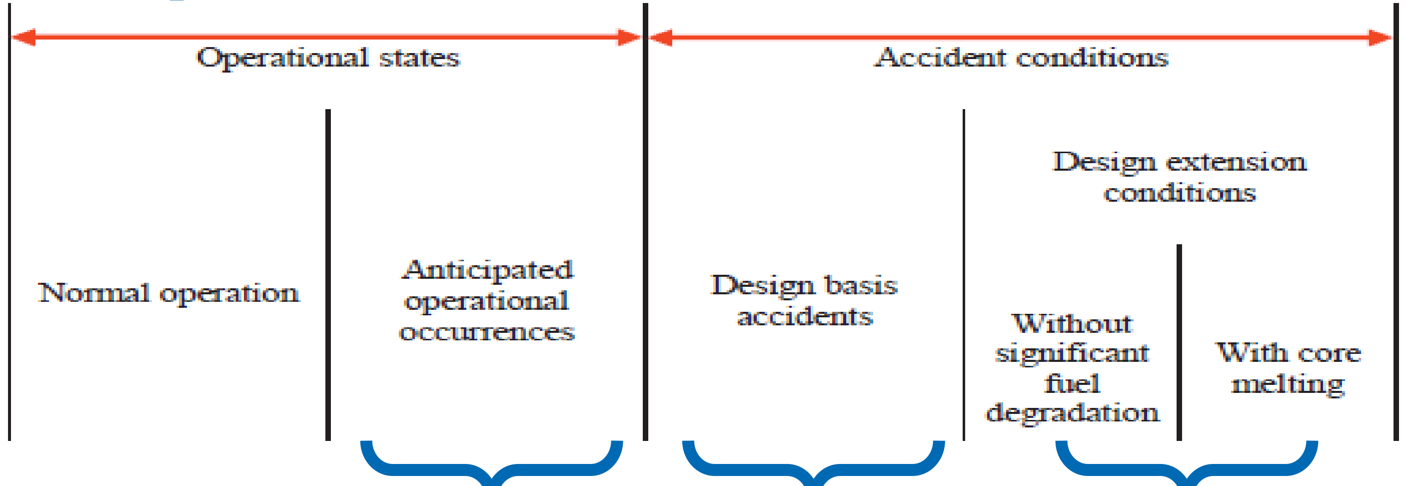
- **Whether adequate provisions have been made** at each of DiD levels to e.g. address deviations from normal operation (NO), control accidents within design limits, mitigate the consequences of accidents that exceed design limits
- **Idenfication of DiD layers of protection:** relevant safety functions, challenges to safety functions and mechanisms of these challenges, provisions to monitor or mitigate the consequences of mechanisms
- **Whether DiD is adequately implemented** (e.g. reducing number of challenges, DiD levels independence)
- **Whether there are adequate safety margins**
- Where practicable, SA shall confirm that there are adequate margins to **avoid cliff edge effects that would have unacceptable consequences.**

SAFETY ASSESSMENT: Requirement 14

Req. 14

SCOPE OF THE SAFETY ANALYSIS

The performance of a facility or activity in **all operational states** and, as necessary, in the post-operational phase shall be **assessed in the safety analysis**.



Example freq. $>10^{-2}$ 10^{-2}-10^{-4} 10^{-4}-10^{-6}

- Whether the facility or activity is in compliance with the relevant **safety requirements and national regulatory requirements.**
- **All plant states** to be considered (considering frequencies and consequences)
- **Relevant operating experience** shall be taken into account in the safety analysis.

SAFETY ASSESSMENT: Requirement 15

Req. 15

DETERMINISTIC AND PROBABILISTIC APPROACHES

Both deterministic and probabilistic approaches shall be included in the safety analysis

- Deterministic and probabilistic approaches **complement one another,** can be used together for integrated decision making
- **Deterministic:** to specify and apply a set of deterministic rules and requirements for the design and operation of facilities or for the planning and conduct of activities. **Conservative.**
  - high degree of confidence that the level of radiation risks to workers and members of the public will be acceptably low).
- **Probabilistic:** to determine all significant contributing factors to the radiation risks, to evaluate whether the design is well balanced and meets probabilistic safety criteria (if any). **Realistic.**

SAFETY ASSESSMENT: Requirements 16-18

Req. 16

CRITERIA FOR JUDGING SAFETY

Criteria for judging safety shall be defined for the safety analysis

Req. 17

UNCERTAINTY AND SENSITIVITY ANALYSIS

Uncertainty and sensitivity analysis shall be performed and taken into account in the results of the safety analysis and the conclusions drawn from it

Req. 18

USE OF COMPUTER CODES

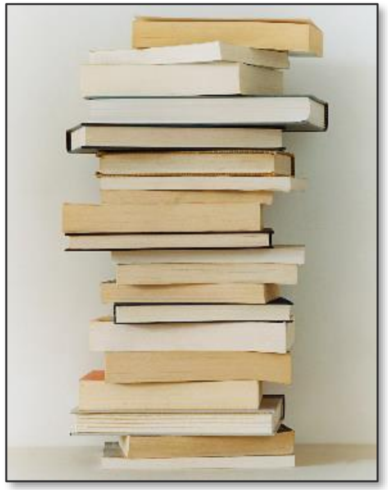
Any calculational methods and computer codes used in the safety analysis shall undergo verification and validation.

SAFETY ASSESSMENT: Requirements 19-21

Req. 19

USE OF OPERATING EXPERIENCE DATA

Data on operational safety performance shall be collected and assessed



DOCUMENTATION OF THE SAFETY ASSESSMENT

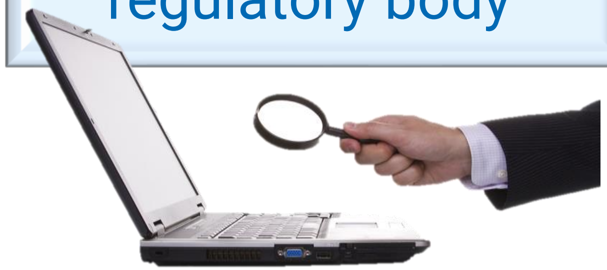
Req. 20

The results and findings of the safety assessment shall be documented

Req. 21

INDEPENDENT VERIFICATION

The operating organization shall carry out an independent verification of the safety assessment before it is used by the operating organization or submitted to the regulatory body

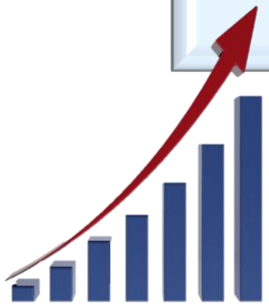


SAFETY ASSESSMENT: Requirements 22-23

Req. 22

MANAGEMENT OF THE SAFETY ASSESSMENT

The processes by which the safety assessment is produced shall be planned, organized, applied, audited and reviewed



Req. 23

USE OF THE SAFETY ASSESSMENT

Safety assessment results shall be used:

- to specify the **programme for maintenance**, surveillance and inspection;

- to **specify the procedures** to be put in place for all operational activities significant to safety and for all plant states;

- to specify the **necessary competences** for the staff involved in the facility or activity;

- to make **decisions in an integrated, risk informed approach**

SAFETY ASSESSMENT: Requirement 24

Req. 24

MAINTENANCE OF THE SAFETY ASSESSMENT

The safety assessment shall be periodically reviewed and updated

- The safety assessment in **itself cannot achieve safety**.
- Safety can only be achieved if the **input assumptions are valid**, derived limits and conditions are implemented and maintained, and the assessment reflects the facility or activity as it actually is at any point in time.
- Facilities and activities change over their lifetimes (e.g. **modifications, effects of ageing**).
- **Knowledge and understanding** also advance with time.
- The safety assessment shall be updated to reflect such changes and **to remain valid.**
- Updating the safety assessment is also important in order to provide a baseline for the **future evaluation of monitoring data and performance indicators**

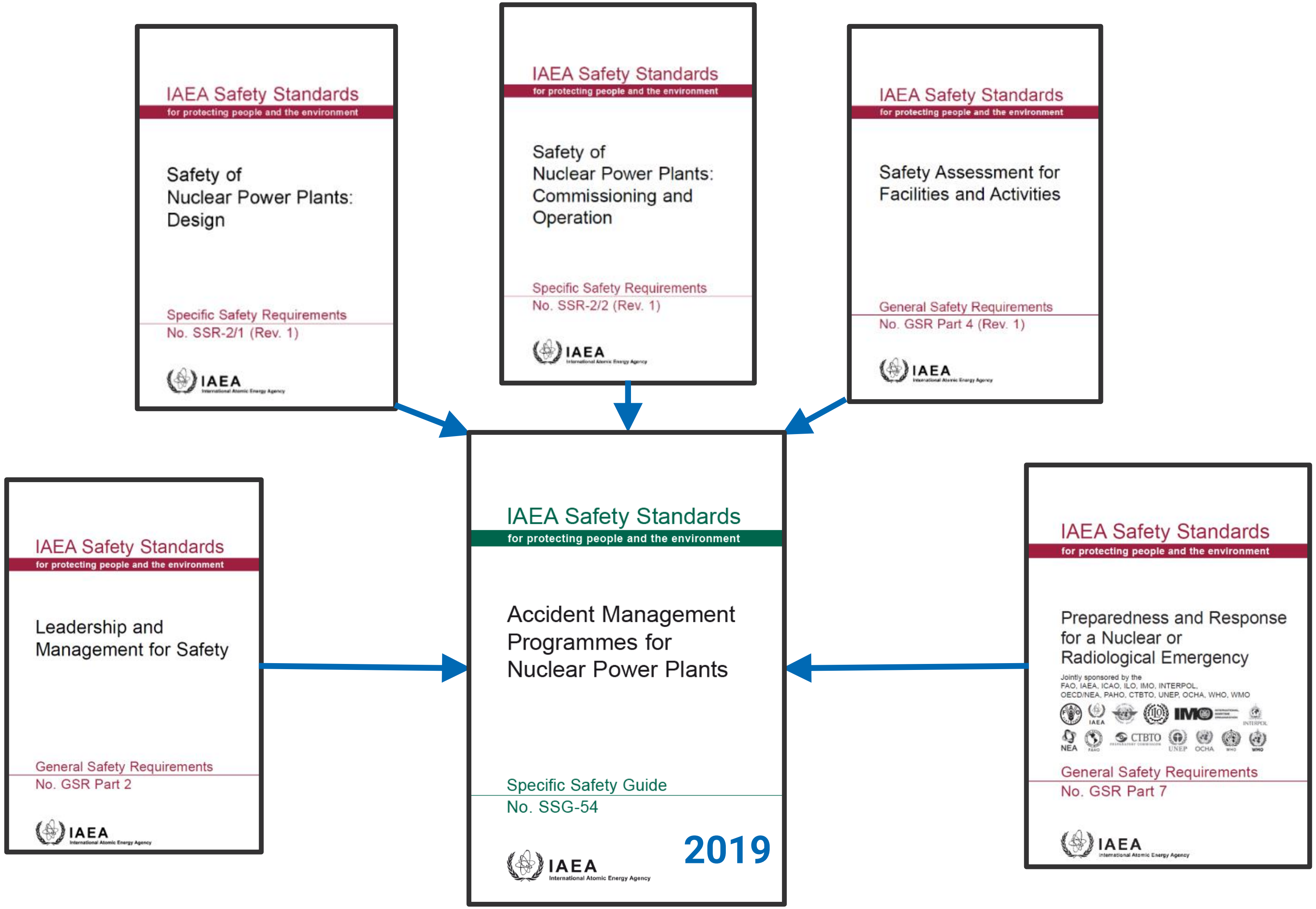
Concluding remarks

The IAEA General Safety Requirements – Safety Assessment for Facilities and Activities GSR Part 4 (Rev.1) (2016)

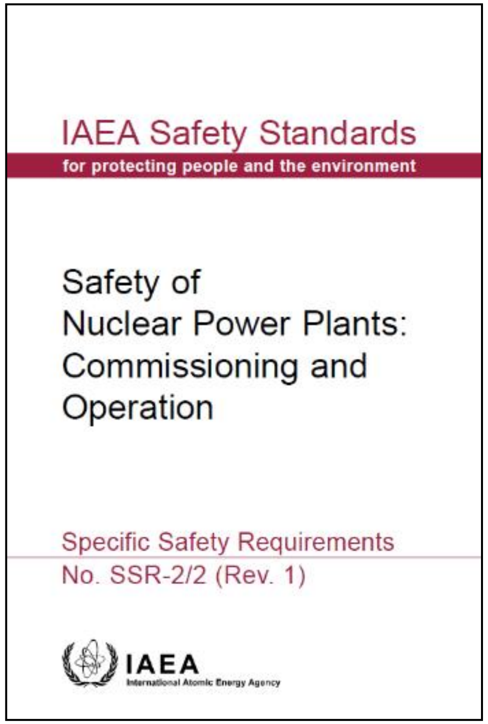
- **Reflects the international consensus** on safety assessment and graded approach
- **Wide scope:** all types of facilities and activities
- **Contains 24 requirements:** Graded approach, Safety Assessment aspects and Management of safety assessment
- **Supported by numerous Safety Guides:** e.g. DSA, PSA, non-reactor facilities
- **Next revision of GSR Part 4** is planned to be initiated in 2026

IAEA SSG-54
Accident Management Programmes for NPPs

SSG-54 interfaces with Safety Requirements



SSR-2/2 (Rev.1) Requirement 19
Accident Management Programme



The operating organization shall establish, and periodically review and as necessary revise, an Accident Management Programme (AMP).

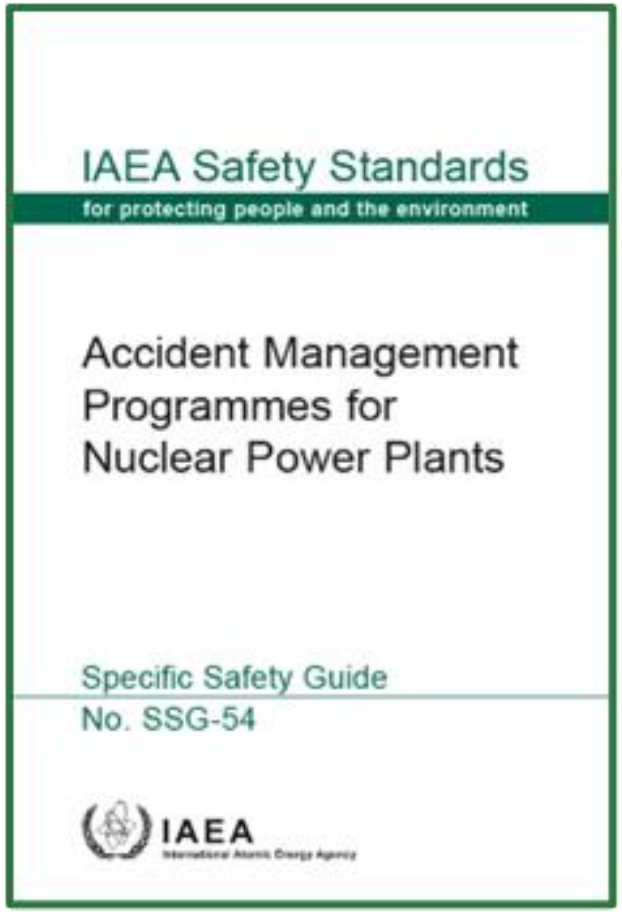
- "An AMP shall be established that covers the preparatory measures, procedures and guidelines, and equipment that are necessary for preventing the progression of accidents, including accidents more severe than design basis accidents, and for mitigating their consequences if they do occur.
- The AMP shall be documented and shall be periodically reviewed and as necessary revised"
- The AMP shall include instructions for the utilization of available equipment — safety related equipment as far as possible, but also items not important to safety (e.g. conventional equipment)". It shall include also contingency measures.
- The AMP shall include the technical and administrative measures necessary to mitigate the consequences of an accident".
- The AMP shall include training necessary for its implementation.

Accident management

- The IAEA Safety Glossary defines 'accident management' as **"The taking of a set of actions during the evolution of an accident to:**
  - **prevent escalation** to a severe accident;
  - **mitigate the consequences** of a severe accident;
  - achieve a **long term safe stable state**."

- **Accident management program (AMP)** is needed for such measures and AMP:
  - encompasses plans and actions undertaken to ensure that plant personnel and other operating organization personnel are adequately prepared **to decide on and implement effective on-site actions**.
  - Essential aspect of DiD application of defence in depth and deals with accidents within and beyond the design basis
  - Needs to be **supported by appropriate safety assessment.**
  - Needs to be **well integrated with the arrangements for EPR**

SSG-54 structure



1. INTRODUCTION

2. GENERAL GUIDANCE FOR AN AMP

- AMP concept, main principles
- Forms of Accident Management Guidance
- Verification and Validation of AMP
- Accident Management for External Hazards and Multi-Unit sites
- Roles and Responsibilities and staffing

3. DEVELOPMENT AND IMPLEMENTATION OF A SEVERE ACCIDENT MANAGEMENT PROGRAMME (SAMP)

- Technical Bases, challenge mechanisms and plant capabilities
- Severe Accident Management Guidance (development, V&V, integration in EPR, hardware provisions)
- Analyses for Development of a SAMP
- Training, Exercises, Drills and updating of SAMP

4. EXECUTION OF THE ACCIDENT MANAGEMENT PROGRAMME

ANNEX: EXAMPLES OF SAMG IMPLEMENTATION IN NPPs

Accident management programmes

- An AMP should be developed and implemented for the prevention and mitigation of severe accidents, **irrespective of the frequency of accident sequences and of fission product releases considered in the design.**
- AMP should address **all modes and states of operation and all fuel locations,** including the spent fuel pool,
- AMP **should take into account possible combinations of events**
- **It should also consider external hazards** more severe than those considered for the design that could result in **significant damage to the infrastructure** on the site or off the site which would hinder actions
- AMP should be developed and **maintained consistent with the plant design** and its current configuration

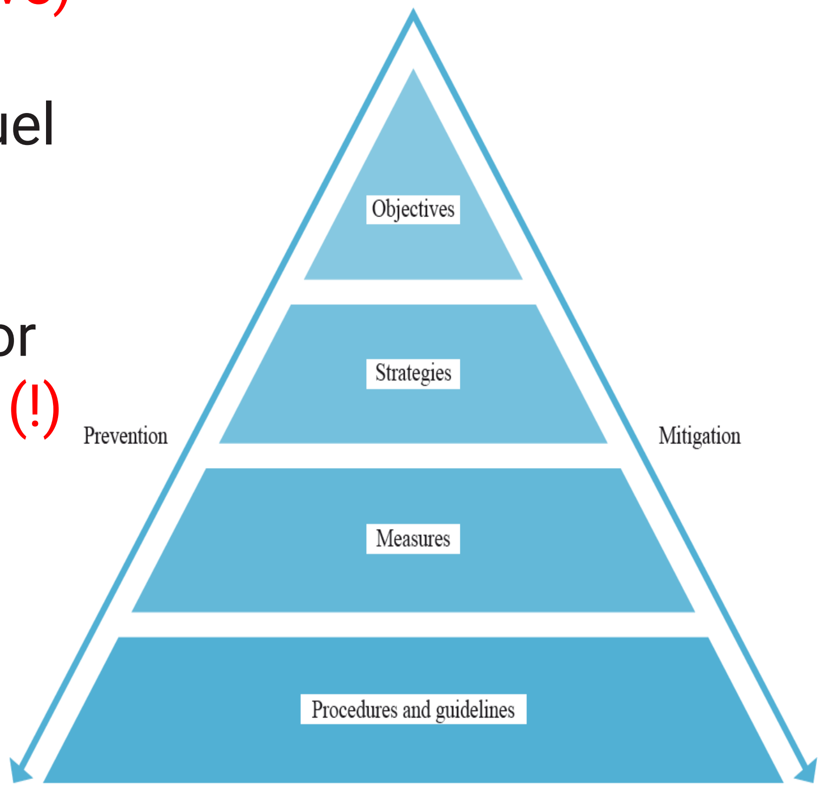
Forms of Accident Management Guidance

Preventive domain (before the onset of fuel rod degradation)

- Actions aimed at **controlling accident progression** to prevent significant fuel damage **or to delay it**
- Guidance is provided in the **form of procedures** (prescriptive)

Mitigatory domain (when a severe accident, i.e. significant fuel degradation, is imminent or in progress)

- Priority is given to mitigating the consequences: avoiding or **limiting fission product releases by containment integrity** (!)
- Guidance is provided in the form of guidelines
  - can be prescriptive for specific actions or
  - offer a range of actions that should be evaluated because of the uncertainties about on plant conditions and accident evolution.



Accident management programmes

Multiple strategies should be identified in preventive and mitigatory domains:

- **Preventing or delaying** the occurrence of fuel rod degradation;
- **Terminating the progress** of fuel rod degradation once it has started;
- **Maintaining the integrity of the reactor pressure vessel** to prevent melt-through especially at high pressure;
- **Maintaining the integrity of the containment** and preventing containment bypass; **Highest priority**
- Minimizing releases of radioactive material from the fuel or at other locations where releases of radioactive material could occur;
- Returning the plant to a long term safe stable state in which the fundamental safety functions can be preserved.

Prioritization of accident management strategies

Accident management strategies **should be prioritized** with account taken of the plant damage state and the existing and anticipated challenges, e.g.:

- **Time frames** and severity of challenges to the barriers
- **Availability of support functions**, as well as the possibility of their restoration.
- **Initial operating mode** of the plant
- **Adequacy of a strategy** in the given domain
- **Difficulty** of implementing several in parallel.
- **Long term implications** of or concerns about their implementation

Trigger should be either certain parameters reach thresholds or trending imminently

Uncertainties should be taken into account (e.g. time windows)

Suitable and effective measures should be derived that correspond to available hardware provisions (e.g. SSCs available, recovery, non-permanent equipment)

Main principles of accident management guidance

Accident management guidance should address the **full spectrum of events**:

- **Promoting consistent implementation** by all staff during an accident.
- **Using the SSCs that are not likely to fail** in the given conditions
- **Instrumentation available and its reliability** for evaluating plant conditions
- **Maintaining SFs** or **increase the margin to failure** or **extending time to failure**
- Adding components, including non-permanent equipment,
- **Human and organizational factors** (e.g. adverse conditions: radiation, lightning temperature, stress)
- **Command and control structure**, information sharing and cooperation

Supporting analyses for AMP

- Accident management procedures and guidelines **should be supported by technical basis documents**, which describe and explain the rationale of the various parts of procedure and guidelines.
- Severe accident management programme should be supported by **appropriate computational analysis showing the progression of representative accident** sequences to be addressed
- **Best estimate computer codes**, assumptions and data regarding initial and boundary plant conditions should be used with proper consideration of uncertainties for timing and severity of the phenomena

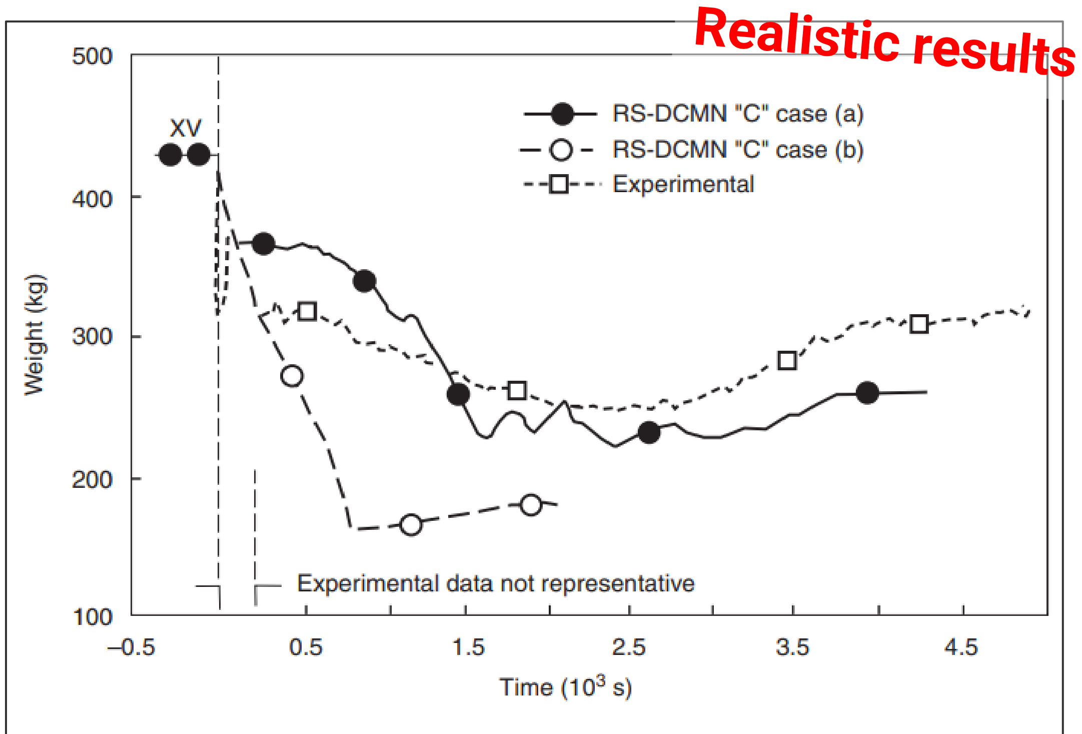


Fig. II–1. Influence of a nodalization inadequacy on code results.

Development of AM procedures and guidelines

Accident management procedures and guidelines should be developed to implement the strategies and measures in the **preventive and the mitigatory domains** (contains instructions on use of equipment, equipment limitations, cautions and benefits)

Preventive	Emergency Operating Procedures (EOPs)	Actions to prevent the escalation of an event into a severe accident
Mitigatory	Severe Accident Management Guidelines (SAMGs)	Actions to mitigate the consequences of a severe accident according to chosen strategies, addressing positive and negative consequences of proposed actions and different options

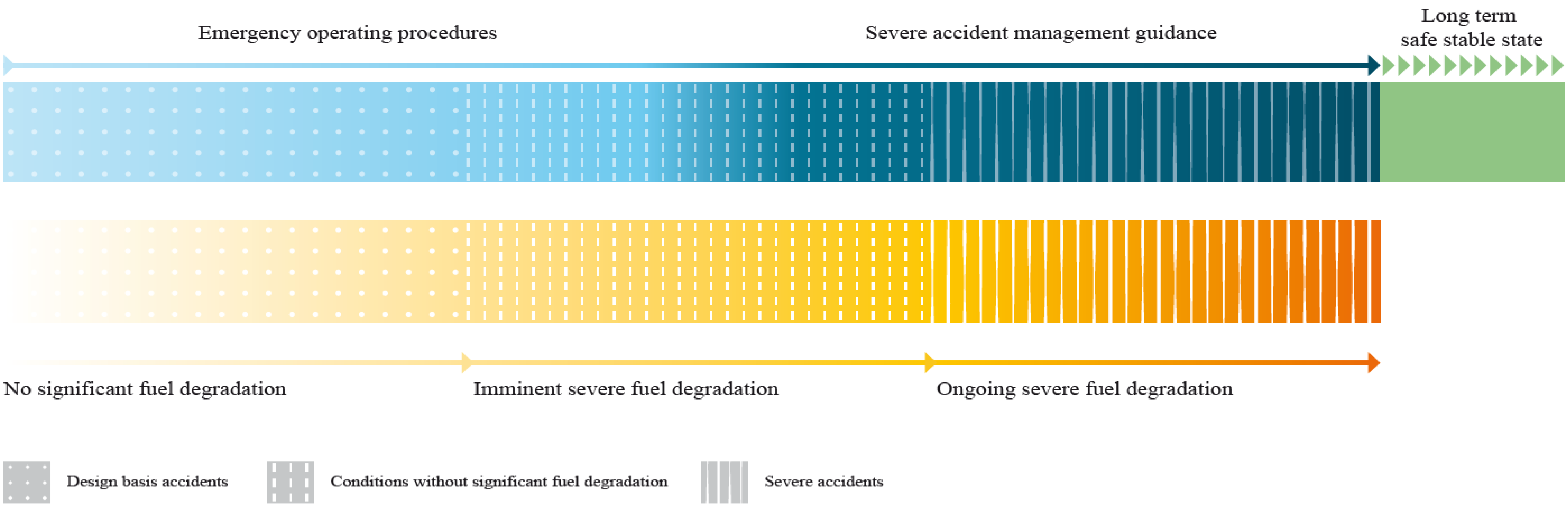
Which is more prescriptive?

The transition point from EOPs to SAMGs should be set with careful consideration of the timing and magnitude of subsequent challenges to the barriers.

Specific and measurable parameter values should be defined for the transition to the use of SAMGs, e.g. core exit temperature.

If the transition point is conditional criteria, the time necessary to confirm the transition point has been reached should be considered.

Summary of Accident management programme



Hardware provisions for AM

- **Equipment in the mitigatory domain** should be focused on preserving the containment function or minimizing releases when the containment has failed

- To increase the equipment capability or its margin to failure:
  - **Monitoring essential containment** parameters (P,T, radiation, etc.)
  - **Ensuring the leak-tightness of the containment**, e.g. functionality of isolation devices and penetrations for a reasonable time.
  - **Establishing or restoring the ultimate heat sink** (removing heat from the containment and molten core)
  - **Control of combustible gases, fission products and other materials released**, including any necessary instrumentation;
  - **Monitoring and control of containment leakages** & fission product releases

Role of Instrumentation & Control System (I&C)

Accident management actions depend on the **ability to measure or estimate** the magnitude of physical and chemical variables and control them.

Instrumentation may not be available (e.g. loss of power, harsh conditions.

Alternative instrumentation should be identified to replace the primary I&C.

Expected failure modes of I&C (e.g. off-scale high, off-scale low, floating behavior) under beyond its design basis conditions should be analyzed.

Infer important plant parameters from local instrumentation.

Guidance should be provided on validating important instrumentation outputs.

Uncertainty of readings of instruments essential for severe accident management should be assessed (in many cases, **trends may be more important** than accuracy).

Verification and validation (V&V) of AMP

Independent V&V processes should assess:

- accuracy and adequacy of the AMP guidance
- ability of personnel to follow and implement them

Verification process should confirm AMP guidance compatibility with referenced equipment, user aids and supplies.

Validation should be carried out to confirm that the specified actions can be followed by trained staff to manage emergency events.

Possible methods for validation of the SAMGs are the use of an engineering simulator (e.g. full scope simulator) and a tabletop method.

Scenarios should be developed that describe fairly realistic (complex) situations that would require the application of major portions of EOPs and SAMGs.

Responsibilities and lines of authorization

The roles of personnel involved in severe accident management should be considered. There are three categories of functions:

- **Evaluation/recommendation** (e.g. assessment of plant conditions, identification of potential actions, evaluation of the potential impacts of these actions, and recommendation of actions)
- **Decision making** / Authorization
- **Implementation of actions**

In an event that degrades into a severe accident, **transfer of responsibilities from the control room staff to a higher level of authority** should be made at some specified point in time.

Education and training

Specific objectives and training needs should be defined for each group involved in accident management, including:

- plant personnel
- management of the operating organization
- other decision making levels,
- regulatory personnel (where applicable)

Regulators, where they participate in utility decisions, should be trained so that they fully understand the basis of proposed utility decisions.

Exercises and drills should be based on appropriate scenarios that will require the application of a substantial number of procedures and guidelines.

Exercises and drills should reflect to the extent possible the expected conditions.

Updating and Managing Severe Accident Management Programme

Following should be reflected in EOPs and SAMGs during their update (this also related to the relevant organisational aspects of accident management):

- change in plant configuration,
- international research on severe accident phenomena
- exchange of information with peers

Development and update of a severe accident management programme should be the **responsibility of the operating organization.**

Operating organization should integrate all the elements of the severe accident management programme **within its management system.**

- so that the processes and activities that may affect safety are established and conducted coherently for the protection of site personnel, public, environment.

Concluding remarks

IAEA Specific Safety Guide SSG-54 - Accident management programme for NPPs (2019)

- **Provides recommendations on accident management for NPPs**

- **Contains "should" statements:** AMP concept, main principles, forms of Accident Management Guidance, V&V of AMP, roles and responsibilities, development and implementation of a severe accident management programme, training, exercises, drills and updating of SAMP

- **Interfacing with Safety Requirements: Design** (SSR-2/1 Rev.1), **Operation** (SSR-2/2 Rev.1) **Safety Assessment** (GSR Part 4 Rev.1), **Leadership and Management** (GSR Part 2) and **Preparedness and Response** (GSR Part 7)

- **Next revision of SSG-54** is planned to be initiated in 2028

Thank you!

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