IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Using PSA for SSC Safety Classification

Workshop on Application of Level 1 Probabilistic Safety Assessment

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Why do we need safety classification for SSCs?

The goal of safety classification is to identify and classify those SSCs that are needed to protect people and the environment from harmful effects of ionizing radiation, based on their roles in preventing accidents, or limiting the radiological consequences of accidents should they occur.

On the basis of their classification, SSCs are then designed, manufactured, constructed, installed, commissioned, operated, tested, inspected and maintained in accordance with established processes that ensure design specifications and the expected levels of safety performance are achieved.

Ranking and None-Ranking Classifications

Obviously, the classification of items by their safety importance should consider ***Ranking*** when stricter regulatory requirements are applied to the items of the higher safety importance for the NPP.

Meanwhile, some classifications – e.g. classifications with the purpose to specify regulatory requirements depending on functions performed by an item (for instance, the systems are divided into protective, control and supporting ones) ***may not be of the ranking*** nature.

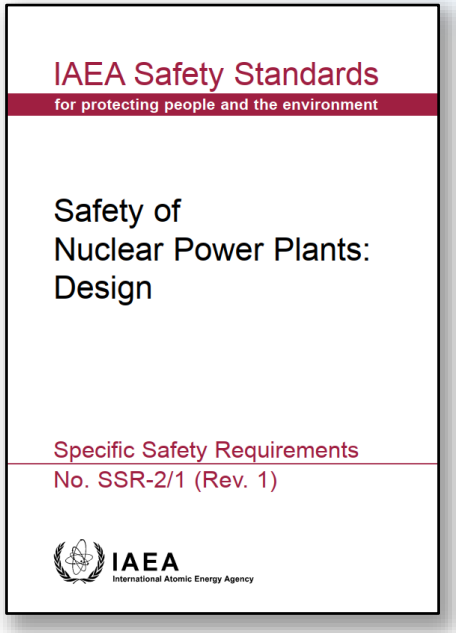
Relevant Statements from IAEA Safety Standards

Requirement 22: Safety classification

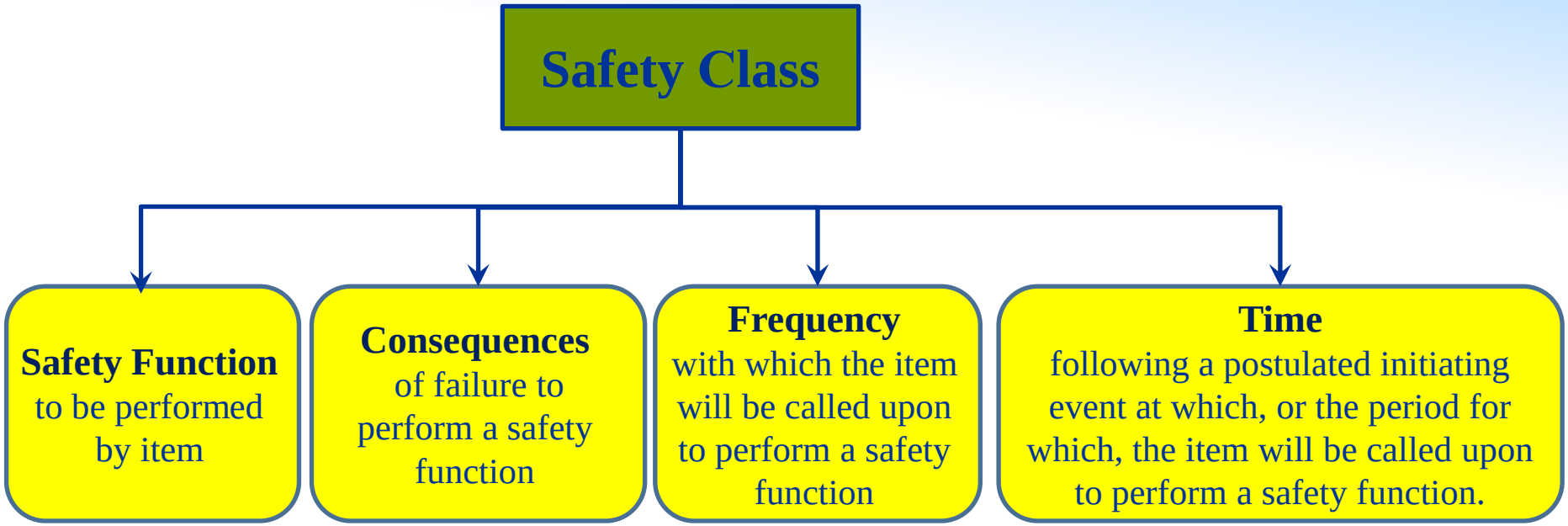
All items important to safety shall be identified and shall be classified on the basis of their function and their safety significance

The method for classifying the safety significance of items important to safety shall be based primarily on **deterministic** methods complemented, where appropriate, by **probabilistic** methods, with due account taken of factors such as:

1) The **safety function**(s) to be performed by the item
2) The **consequences of failure** to perform a safety function
3) The **frequency** with which the item will be called upon to perform a safety function
4) The **time** following a postulated initiating event at which, or the period for which, the item will be called upon to perform a safety function



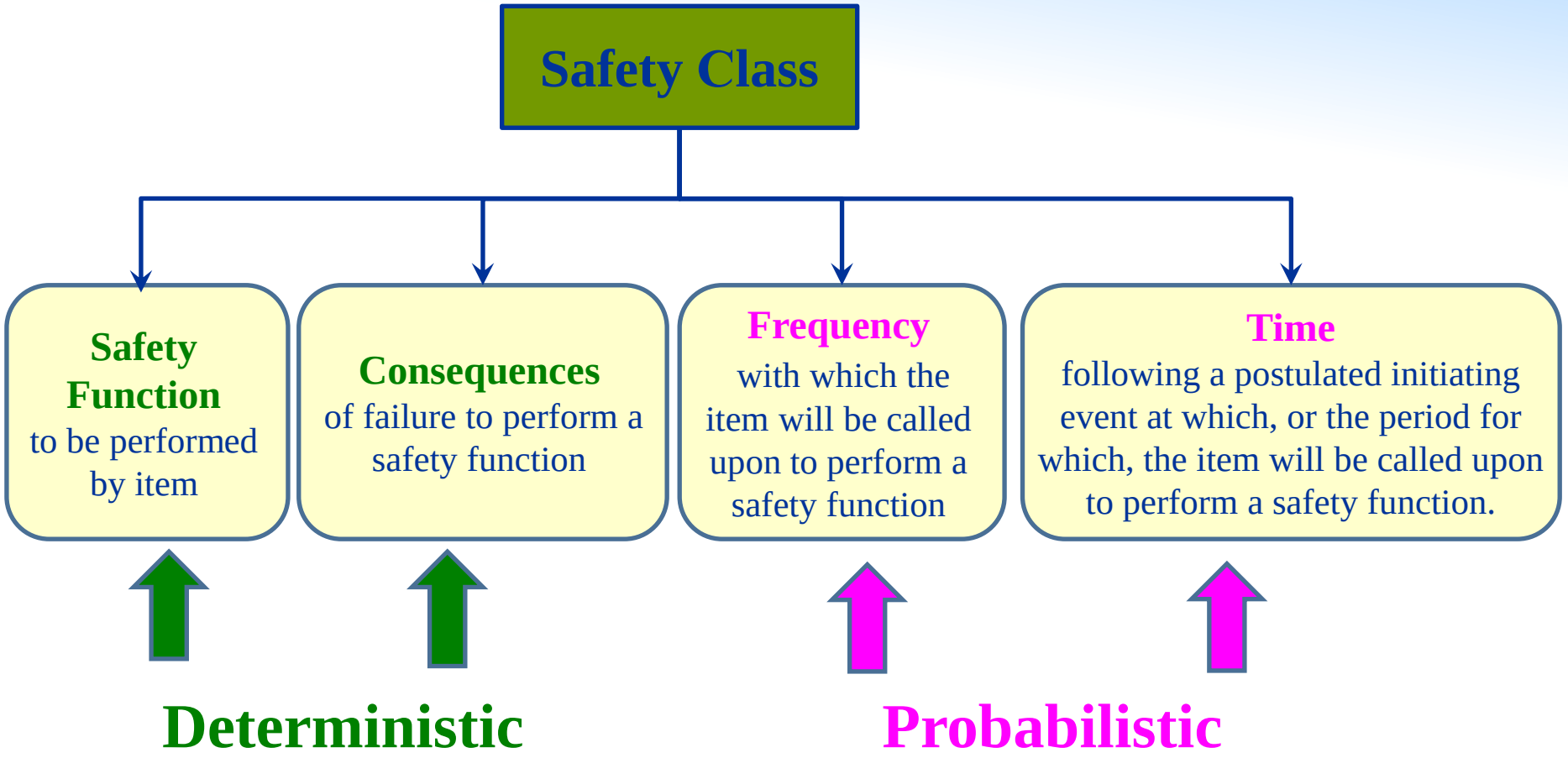
Relevant Statements from IAEA Safety Standards



IAEA SSR-2/1 Rev.1, Requirement 22:

The method for classifying the safety significance of items important to safety shall be based primarily on ***deterministic methods*** complemented, where appropriate, by ***probabilistic methods***, with due account taken of factors such as: (a) The safety function(s) to be performed by the item; (b) The consequences of failure to perform a safety function; (c) The frequency with which the item will be called upon to perform a safety function; (d) The time following a postulated initiating event at which, or the period for which, the item will be called upon to perform a safety function.

Relevant Statements from IAEA Safety Standards



Relevant Statements from IAEA Safety Standards

Requirement 4. Fundamental safety functions

Fulfilment of the following fundamental safety functions for a nuclear power plant shall be ensured for all plant states:

- ✓ control of reactivity
- ✓ removal of heat from the reactor and from the fuel store and
- ✓ confinement of radioactive material, shielding against radiation and control of planned radioactive releases, as well as limitation of accidental radioactive releases.

A systematic approach shall be taken to identifying those items important to safety that are necessary to fulfil the fundamental safety functions and to identifying the inherent features that are contributing to fulfilling, or that are affecting, the fundamental safety functions for all plant states.

Requirement 18. Engineering design rules

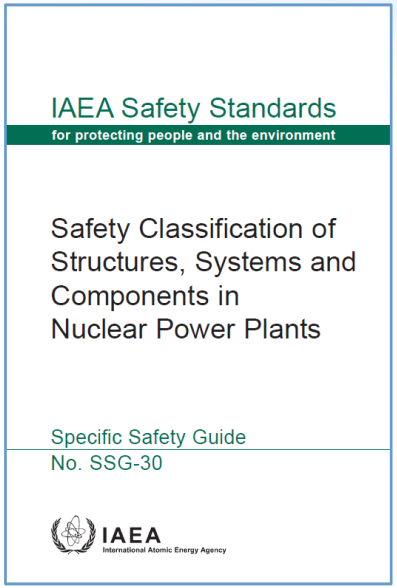
The engineering design rules for items important to safety at a nuclear power plant shall be specified and shall comply with the relevant national or international codes and standards and with proven engineering practices, with due account taken of their relevance to nuclear power technology.

Requirement 27. Support service systems

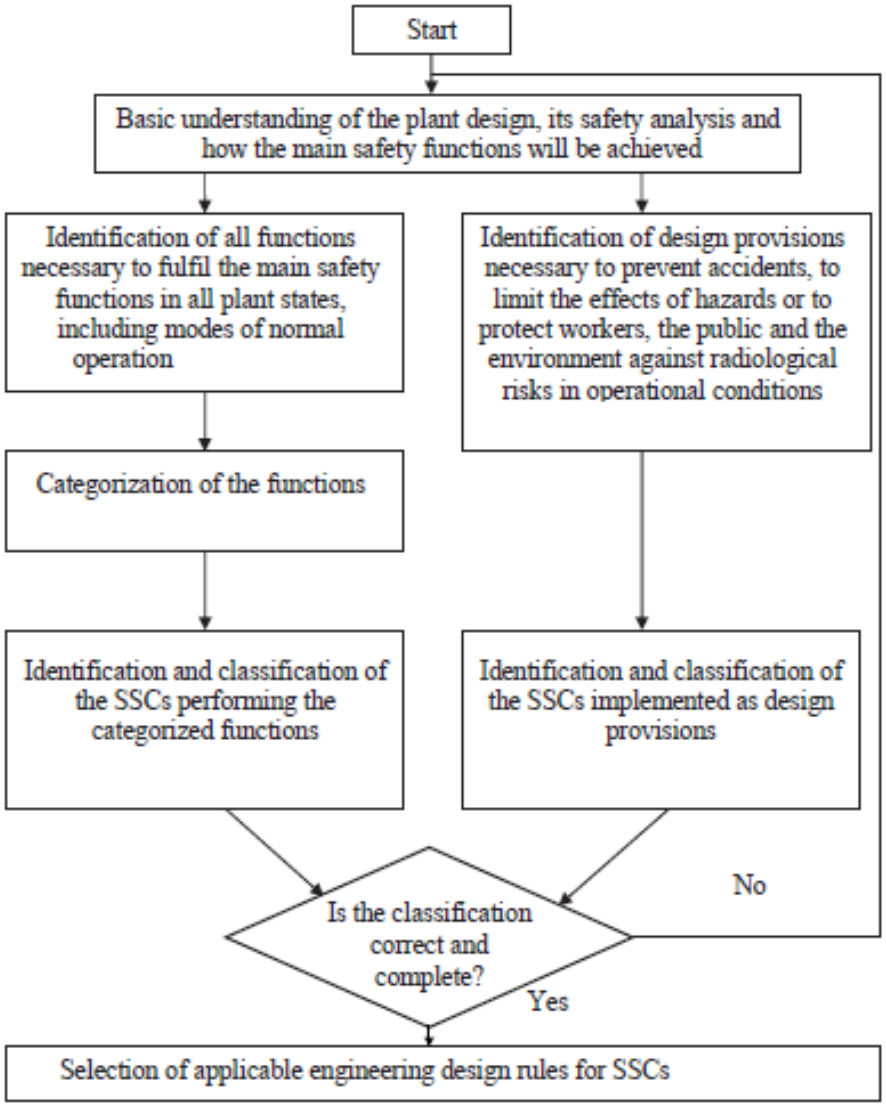
Support service systems that ensure the operability of equipment forming part of a system important to safety shall be classified accordingly.

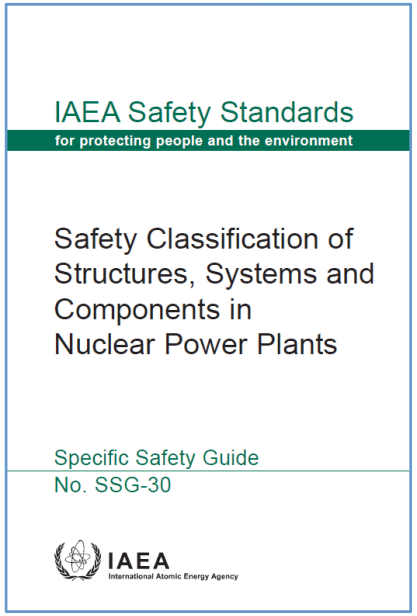
Safety Classification in Structures, Systems and Components in Nuclear Power Plants

Specific Safety Guide SSG-30



General Flowchart of Classification Process





Categorization of Safety Functions

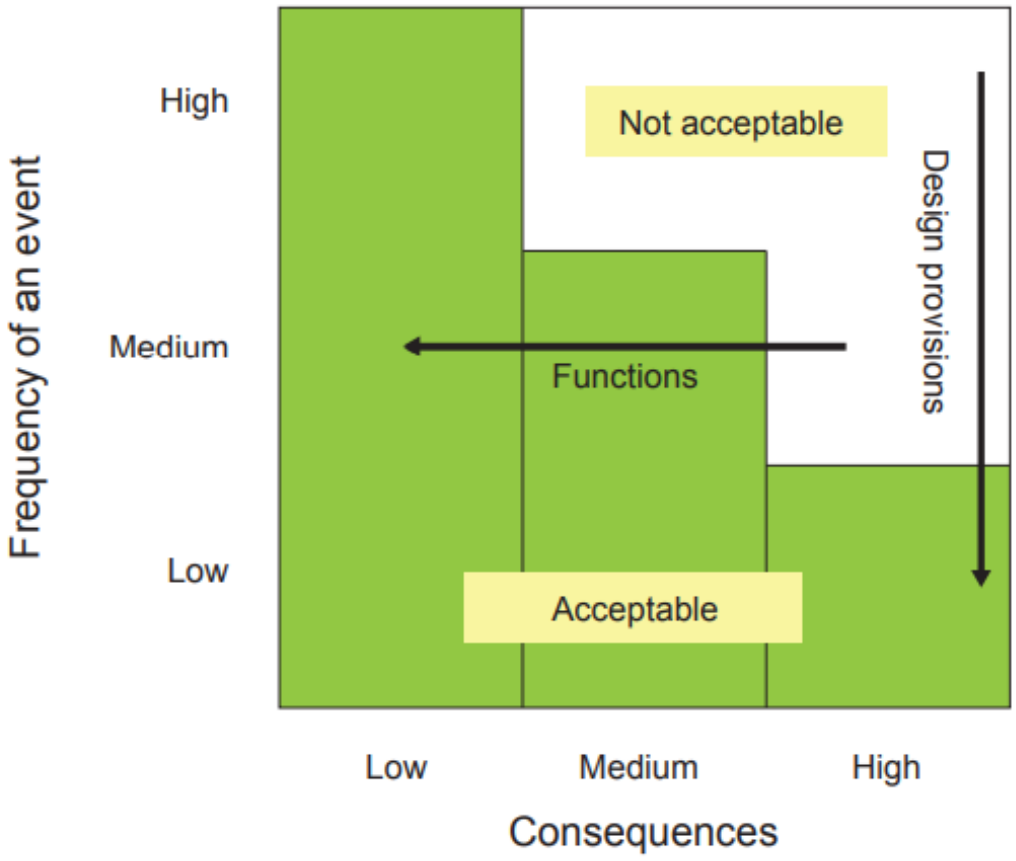
The functions should then be categorized into a limited number of categories on the basis of their safety significance, using an approach that takes account of the following factors:

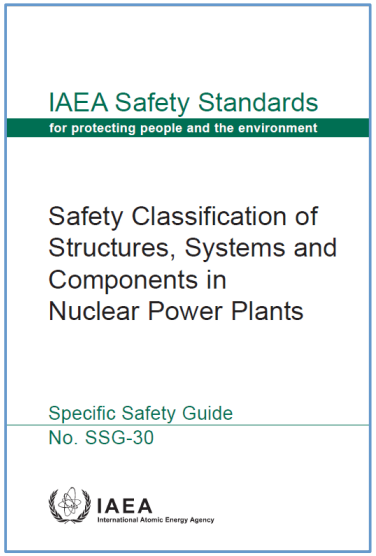
(1) The **consequences** of failure to perform the function

(2) The **frequency of occurrence** of the postulated initiating event for which the function will be called upon

(3) The **significance of the contribution** of the function in achieving either a **controlled state** or a **safe state**

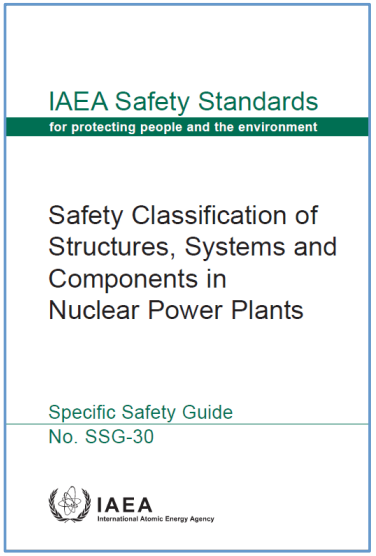
Frequency versus Consequences





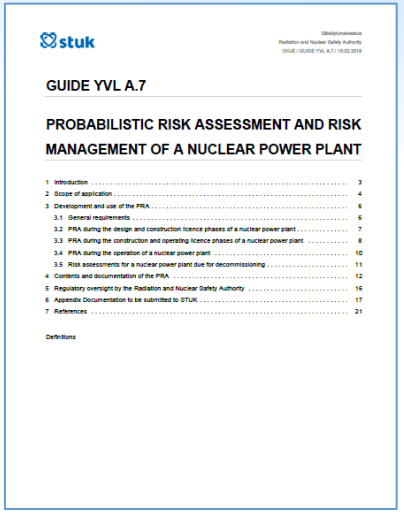
Relations Between Functions and Safety Categories

Functions credited in the safety assessment	Severity of consequences if the function is not performed		
	High	Medium	Low
Functions to reach a controlled state after anticipated operational occurrences	SC 1	SC 2	SC 3
Functions to reach a controlled state after design basis accident	SC 1	SC 2	SC 3
Functions to reach and maintain a safe state	SC 2	SC 3	SC 3
Functions to mitigate consequences of DEC	SC 2 or 3	Not categorized	Not categorized



Example of Regulatory Provisions for Safety Classification of SSCs

YVL-A.7- 313. The PRA shall be applied to determine the safety classification of structures, systems and components in accordance with Guide YVL B.2. It shall be ensured by the PRA that the safety classification of every structure, system and component corresponds to its safety significance.
The PRA application regarding safety classification shall be submitted to STUK for information with the safety classification document.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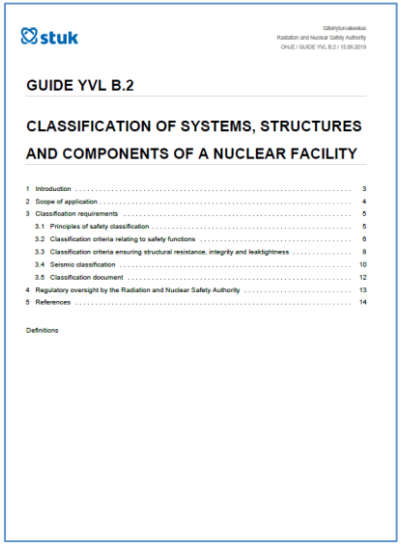
GUIDE YVL A.7

PROBABILISTIC RISK ASSESSMENT AND RISK MANAGEMENT OF A NUCLEAR POWER PLANT

Definitions

YVL-B.2-301. Classification of the nuclear facility's systems, structures and components shall primarily be based on deterministic methods supplemented, and complemented by PRA and expert judgement. Requirements of producing and use of the PRA are stated in guide YVL A.7YVL-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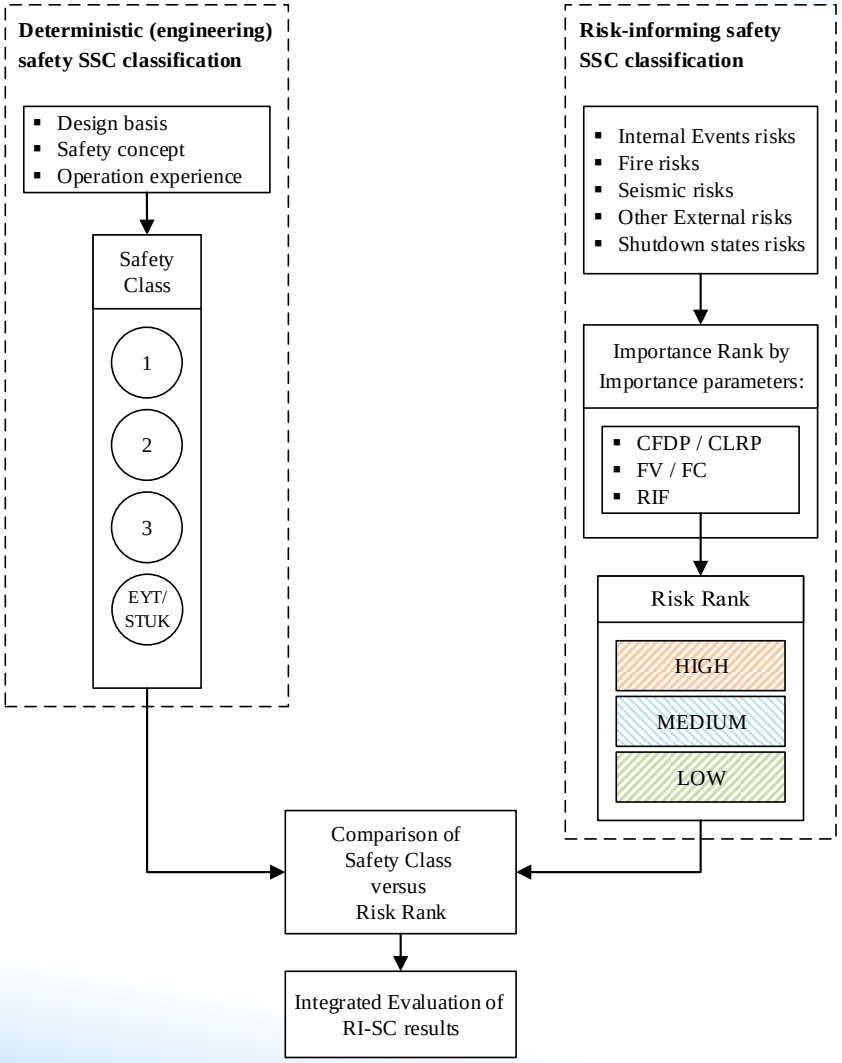
GUIDE YVL B.2

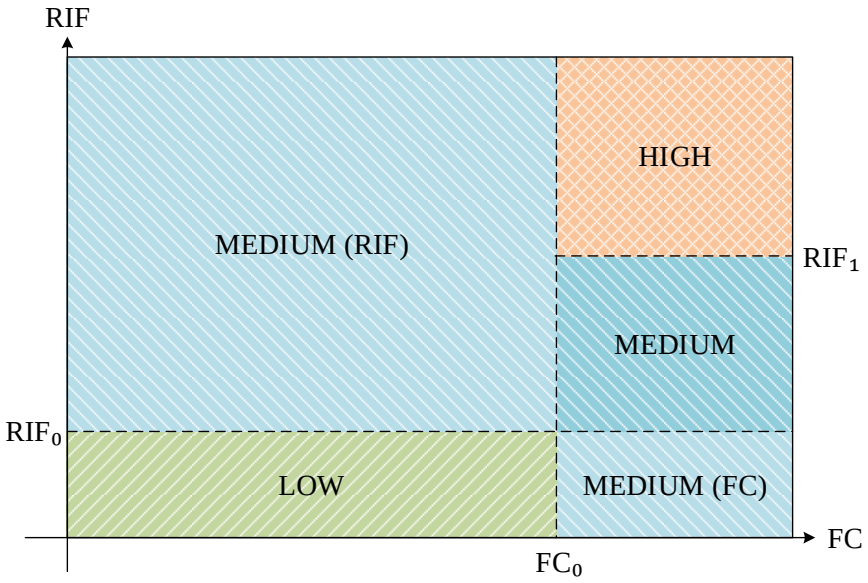
CLASSIFICATION OF SYSTEMS, STRUCTURES AND COMPONENTS OF A NUCLEAR FACILITY

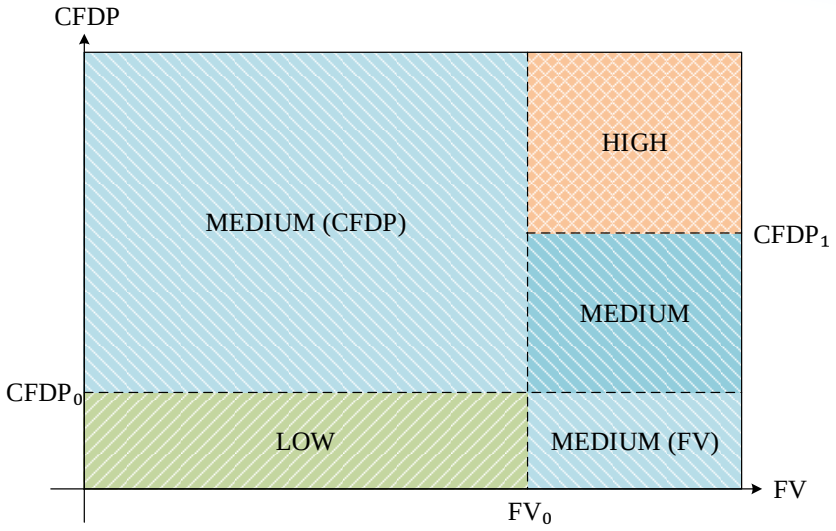
Definitions

Example of Risk-informed SSC Categorization Algorithm



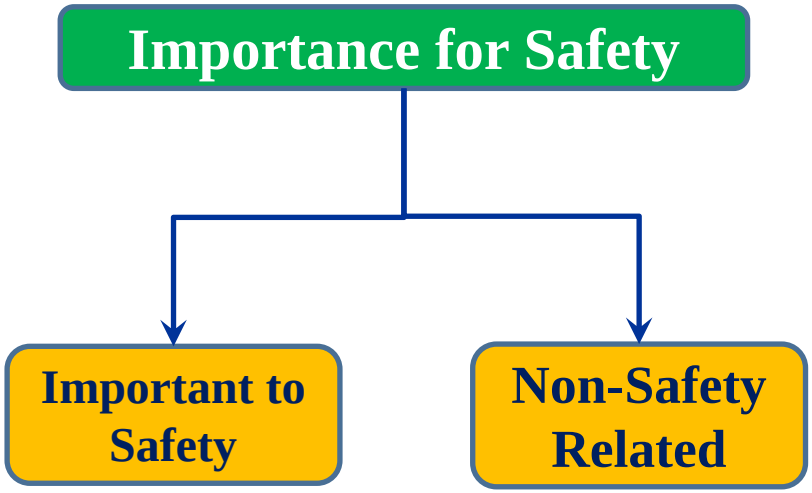
Examples of Categorization Maps

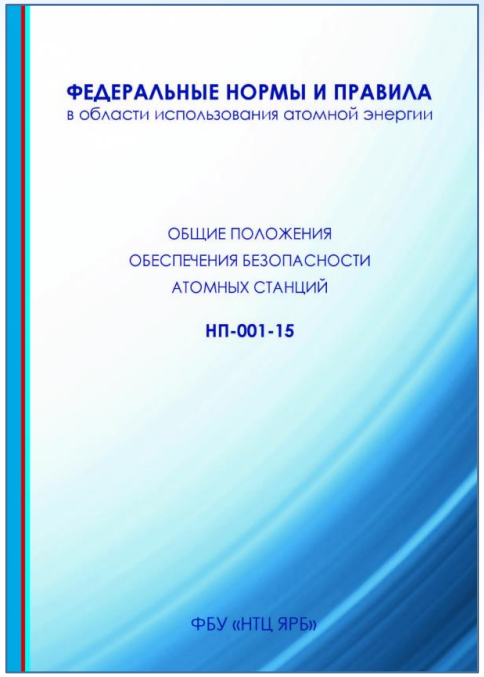




Example of Regulatory Provisions for Safety Classification of SSCs

NP-001-15. High Level Classification





- ✓ Applicable to both systems and elements.
- ✓ Allows to specify systems and elements which are subject for special regulation due to their role in ensuring NPP safety.
- ✓ Special regulation includes quality assurance requirements, rules for ensuring reliability, requirements for operability confirmations, other rules for designing and operation.

Example of Regulatory Provisions for Safety Classification of SSCs

Classification Rules

Rule No	Classification Rule	Applied Classification Criteria
1	Affiliation with safety systems (elements)	• Involvement into implementation of the **third level of DiD**. • Decrease in NPP preparedness for DBA (degradation of the third level of the DiD) in case of a system (element) failure.
2	Affiliation with systems (elements) of normal operation whose failure breaches NPP normal operation, if the **conditional probability** of this failure developing into a severe accident is **10^{-6}** or higher	• Involvement into implementation of the **first level of DiD.** • Degradation of the DiD first level in case of a system (element) failure, the need in actuation of systems related to the further DiD levels due to the failure of an NPP element. • The **probability of inefficient operation of further DiD levels** (conditional probability of a system (element) failure developing into a severe accident).

Example of Regulatory Provisions for Safety Classification of SSCs

Classification Rules

Rule No	Classification Rule	Applied Classification Criteria
3	Affiliation with systems (elements) of normal operation whose failure prevents from elimination of breach of NPP normal operation, if the **conditional probability** of this failure developing into a severe accident is 10^{-6} or higher	• Involvement of a system (element) into implementation of the **second level of DiD**. • Decrease in NPP preparedness for reacting to abnormal operation (degradation of the second level of DiD) due to a failure of an NPP system (element). • The **probability of inefficient operation of other DiD levels** (conditional probability of a system (element) failure developing into a severe accident).
4	Affiliation with NPP systems (elements) whose failure leads to excess of established values for maximal permissible releases or permissible discharges of radioactive substances, or permissible levels of NPP premises radioactive contamination	• Involvement of a system (element) into implementation of the **first or level of DiD**. • Radiological consequences of a system (element) failure.

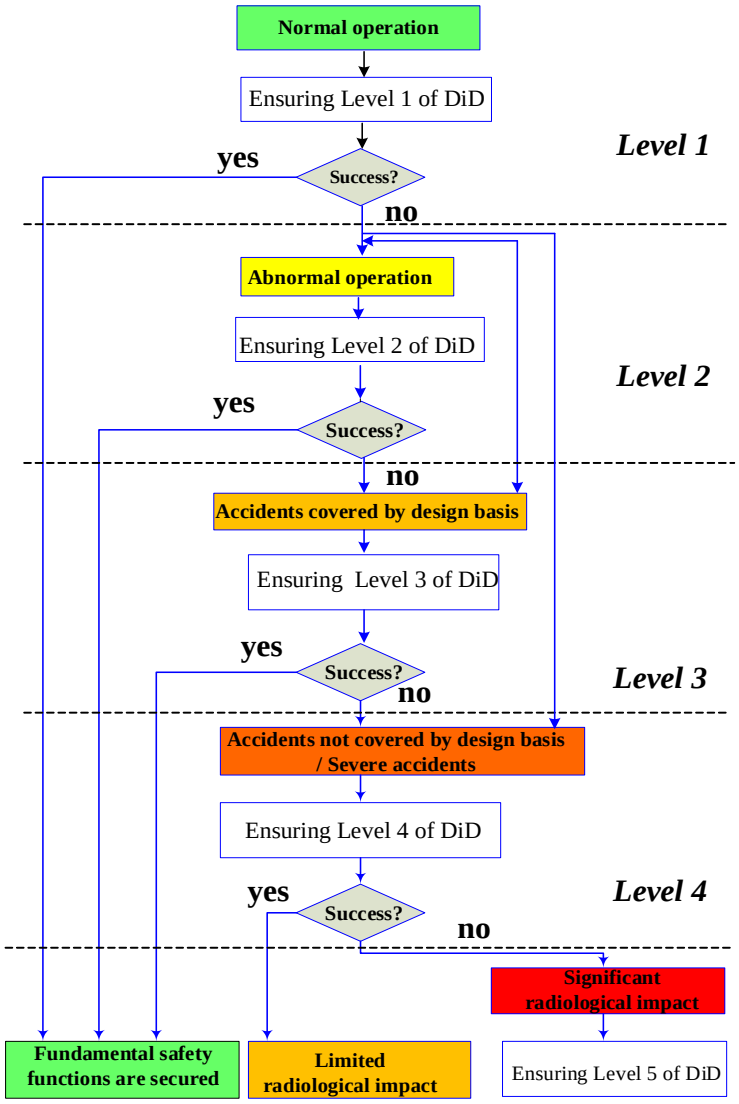
Example of Regulatory Provisions for Safety Classification of SSCs

Classification Rules

Rule No.	Classification Rule	Applied Classification Criteria
5	Affiliation with systems (elements) provided in the NPP design for accident management during **first three days** after an initiating event (or during another period determined in the NPP design which shall be at least three days);	• Involvement of a system (element) into implementation of the **fourth level of DiD**. • **Time period** since the moment of an initiating event occurred after which a system (element) should be in operation.
6	Affiliation with the systems (elements) of radiation monitoring.	• Involvement of an NPP element into implementation of the DiD (**levels 1-5 of the DiD**) as regards to the monitoring of radiation parameters.

Overview of Classification Criteria

DiD scheme



Applicable Classification Criteria

Involvement into DiD Level 1	+	Rad. consequences of SSC failure or Significant CCDP in case of SSC failure
Involvement into DiD Level 2	+	Significant CCDP in case of SSC failure
Involvement into DiD Level 3		
Involvement into DiD Level 4	+	Time from IE
Involvement into DiD Level 5 (radiation monitoring)		

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Thank you for your attention
Questions?