EUROPEAN UTILITY REQUIREMENTS
FOR LWR NUCLEAR POWER PLANTS

VOLUME 1

MAIN POLICIES AND OBJECTIVES

CHAPTER 4

EUR KEY ISSUES

Revision E1

December, 2020

List and status of the sections of the Chapter 1.4 Revision E, December 2020

EUR KEY ISSUES

Revision E1 *Update 2020*

1.4 1 INTRODUCTION

The EUR Key Issues represent the principal requirements to be met by a Light Water Reactor (LWR) design to be built in Europe. They cover different aspects of performance expected by the European Utilities and are aligned with the EUR Policies.

They reflect the need for the design to:
- Achieve high levels of safety and environmental protection;
- Respect the limitations of human performance;
- Meet operational performance targets; and
- Provide a robust investment proposition.

The EUR Key Issues (KI) have been selected from individual requirements of the EUR Document (and sometimes combine several requirements) which have a significant impact on the overall design standards to be achieved by the plant. Individual requirements are presented in the EUR Key Issues without their associated comments and the original text of the Volume 2 requirements has sometimes been modified in order to be self-standing (e.g. in KI 1, KI 6 and KI 8, by replacing references to requirements in Volume 2, not provided in this Chapter 1.4, by additional text or references to other KIs).

In general, the list of the EUR Key Issues is presented in the order that the requirements appear in Volume 2 (Chapter 2.1, Chapter 2.2, etc.).

The EUR Key Issues provide also a high level overview of the EUR Document and an illustration of the way the requirements are presented in the EUR Document.

1.4 2 USE OF THE KEY ISSUES IN THE ASSESSMENT OF REACTOR DESIGNS

Vendors* of NPPs may apply for an assessment of one of their designs against the current revision of the EUR Document. The EUR assessment principles which define the approach to the assessment are provided in Chapter 1.1, Section 1.1.5.1.

A pre-assessment of their designs against the EUR Key Issues is undertaken by the Vendors* as the initial step of the overall assessment. This step should be based on the original text of requirements and associated comments provided in Volume 2. The pre-assessment provides confidence to the EUR members that the Vendors* design will be generally in line with the EUR Document and is also sufficiently well developed to allow a detailed EUR assessment of compliance against requirements of Volume 2.

Nevertheless, the result of pre-assessment against EUR Key Issues should not be considered as proof of compliance of the overall design, which can be only gained through the detailed EUR assessment.

1.4 3 LIST OF THE EUR 53 KEY ISSUES (KI)

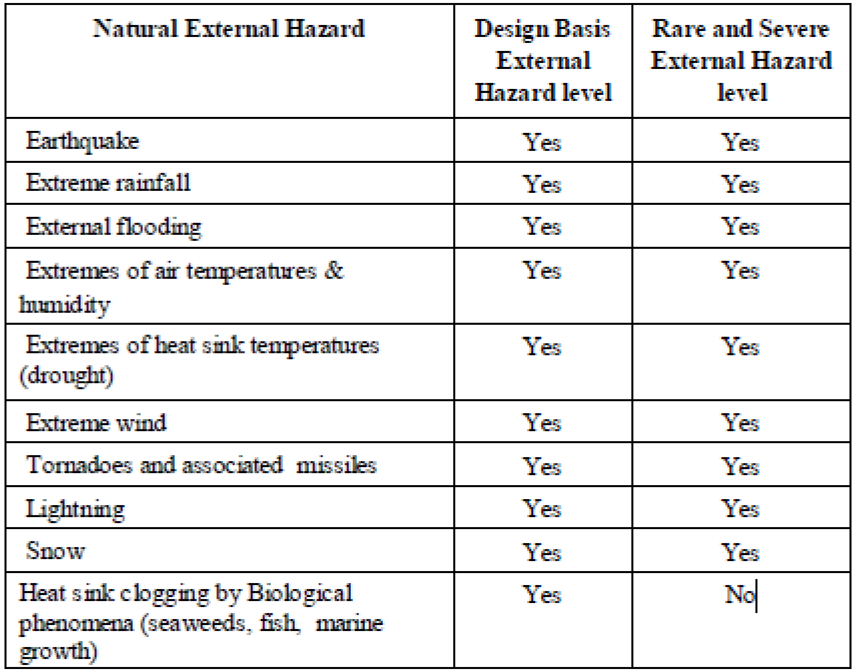
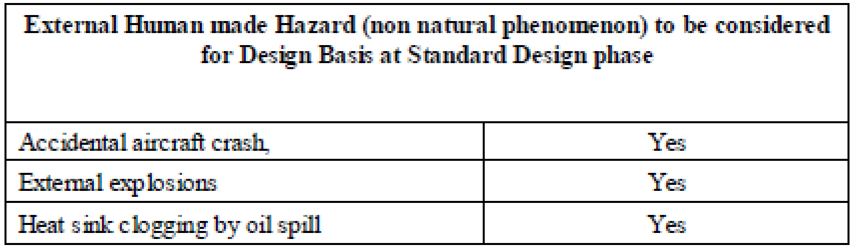
<table>
<tr><th>KI n°</th><th>Topic</th><th>Section Requirement</th><th>Text of the Key Issues</th></tr>
<tr><td>KI 1</td><td>Application of Defence-in-Depth</td><td>2.1.1.4
A</td><td>A - The design of the plant shall incorporate Defence in Depth* (DiD). The Defence in Depth* concept shall be applied to provide required levels of defence (as indicated in the Table below) that are aimed at:
• Preventing consequences of accidents that could lead to harmful effects on people and the environment;
• Ensuring that appropriate measures are taken for the protection of people and the environment; and
• The mitigation of consequences in the event that prevention fails.
<table>
<tr><th>Levels of DiD</th><th>Objective</th><th>Essential means</th><th>Radiological safety objectives (1)</th><th>EUR radiological targets (2)</th><th colspan="2">Plant States</th><th>Design conditions</th></tr>
<tr><td>Level 1</td><td>Prevention of abnormal operation and failures</td><td>Conservative design and high quality in construction and operation</td><td rowspan="2">O1</td><td rowspan="2">Doses to the public during Normal Operation* and Anticipated Operational Occurrences*
(Section 2.1.3.2.2 in KI 7)</td><td rowspan="2">Operational States*</td><td>Normal Operation*</td><td>DBC-1</td></tr>
<tr><td>Level 2</td><td>Control of abnormal operation and detection of failures</td><td>Control, limiting and protection systems and other surveillance features</td><td>Anticipated Operational Occurrences*</td><td>DBC-2</td></tr>
<tr><td>Level 3a</td><td>Control of Design Basis Accidents*</td><td>Safety Systems* and accident procedures</td><td rowspan="2">O2</td><td>Targets for Design Basis Accidents* given in Section 2.1.3.3 in KI 8</td><td rowspan="3">Accident Conditions*</td><td>Design Basis Accidents*</td><td>DBC-3
DBC-4</td></tr>
<tr><td>Level 3b</td><td>Control of Complex Sequences* & prevention of core melt</td><td>Dedicated Safety Features for DEC* to prevent core melt and accident procedures</td><td>Target for Complex Sequences* given in Section 2.1.3.3 in KI 8</td><td rowspan="2">Design Extension Conditions*</td><td>Complex Sequences*</td></tr>
<tr><td>Level 4</td><td>Control of accidents with core melt to limit off-site releases</td><td>Dedicated Safety Features for DEC* to mitigate core melt and accident management</td><td>O3</td><td>CLI target for Severe Accidents* given in Section 2.1.3.4 in KI 8</td><td>Severe Accidents*</td></tr>
<tr><td>Level 5</td><td>Mitigation of radiological consequences of significant releases of radioactive material</td><td>On-site and Off-site emergency preparedness and response</td><td>–</td><td>–</td><td></td><td>–</td><td>–</td></tr>
</table>
Table: EUR representation of Defence-in-Depth* and associated Plant States*, based on WENRA and IAEA approaches.
(1) See WENRA RHWG Report Safety of new NPP designs, March 2013, for the explanation of safety objectives O1, O2, O3
(2) EUR Radiological targets are defined in accordance with EUR safety objectives given in Section 2.1.3 in KI 7 and KI 8</td></tr>
</table>

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 2	**Design Conditions - Design Basis Accidents**	**2.1.2.3 A-B-C**	A - A set of accidents that are to be considered in the design shall be derived from Postulated Initiating Events* for the purpose of establishing the boundary conditions for the plant to withstand, without exceeding applicable safety objectives and off-site release targets. B - Design Basis Accidents* shall be used to define the design bases, including performance criteria, for Safety Systems* and for other Items Important to Safety* that are necessary to control Design Basis Accidents*, with the objective of returning the plant to a Safe State* and mitigating the consequences of any Design Basis Accidents*. C - The design shall be such that for Design Basis Accidents*, key plant parameters do not exceed the specified design limits. A primary objective shall be to manage all Design Basis Accidents* so that they have no, or only minor, radiological impacts, on or off the Site*, and do not necessitate any off-site intervention measures.
	Design Conditions - Complex Sequences	**2.1.2.4.1 A-B-C-D-E**	A - For Complex Sequences, the identification process starts with an intermediate list of Postulated Initiating Events* that shall include: • Design Basis Conditions 2* or most frequent Design Basis Conditions 3* combined with postulated Common Cause Failure* of redundant trains of needed Safety Systems*; and • Complex or specific scenarios including Common Cause Failures* of systems needed to fulfil the Fundamental Safety Functions* in Normal Operation*. B - Probabilistic methods should be used in identifying additional events such as random failures that affect simultaneously several Safety Systems*, or Common Cause Failure* affecting similar equipment in several Safety Systems*. C - A selection of a reasonable number of limiting (bounding) cases shall be made to identify the additional Safety Features for Design Extension Conditions* and define the performance criteria for Items Important to Safety* using operational experience feedback, engineering judgment and probabilistic assessment. In choosing the Complex Sequences* to be addressed in the design, the following factors should be considered together: • The frequency of the event; • The Grace Period* for necessary human actions; • The margins to Cliff Edge Effects*; and • The radiological or environmental consequences of the event. D - Any general screening/exclusion rule (if applied) for selection of Complex Sequences* shall be justified. E - Safety Features for Design Extension Conditions* used in Complex Sequences* shall be, as far as reasonably practicable, independent of Safety Systems*

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 3	**Design Conditions** **-** **Severe Accidents**	**2.1.2.4.2** **A-B-C-D-E**	A - At least one representative accident sequence involving significant Core Damage* shall be identified and considered in the design as a Severe Accident* scenario. Additional accident sequences should be identified as Severe Accidents* in order to assure that the overall probabilistic safety targets (see Section 2.1.3.5 in KI8) are met. B - In Severe Accidents* the containment structure is the main Physical Barrier* for protecting the environment from the radioactive materials. Maintaining the integrity of the Primary Containment* in the long term shall be the main objective. C - In addition to the containment structure there shall be Safety Features for Design Extension Conditions* included in the design of the plant and procedures implemented to mitigate the consequences of core melt accidents. D - The selected accident sequence shall be sufficient to form an adequate design bases for the Containment System* and for any Safety Features for Design Extension Conditions* implemented to mitigate the consequences of core melt accidents. E - Safety Features for Design Extension Conditions* used in Severe Accidents* shall be, as far as reasonably practicable, independent of Safety Systems* and Safety Features for Design Extension Conditions* used in Complex Sequences*.
KI 4	**Reference Source Term**	**2.1.2.4.3.2** **A-B-C**	A - The reference Severe Accident* for the quantification of the RST shall be determined by the Designer* on the basis of the specific characteristics of the design. B - The reference Severe Accident* shall be design-specific, since it is required to be a mechanistic sequence which is treated realistically. Therefore Best Estimate Analysis* shall be considered for RST definition. C - One reference Severe Accident* shall be selected, as that sequence which leads to the most representative In-Containment Source Term* among the Severe Accident* sequences considered as DECs.
	PSA Evaluation Source Term	**2.1.2.4.3.4** **A-B**	A - On the basis of Level 2 PSA, releases associated with each sequence family shall be assessed. The Designer* shall compare each of these releases with that associated with the RST. Cases where the release exceeds the RST release shall be reported and explained for sequence families with probabilities in the range of 10^{-7} per year and higher. B - The cumulative probability of all sequences that exceed the RST release or are not evaluated shall be less than 10^{-6} per year. Otherwise either the RST shall be revised or a design modification shall be introduced

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 5	**Practical Elimination**	**2.1.2.5 A-B-C**	A - Accident sequences that have the potential to cause a Large Release* or Early Release* shall be Practically Eliminated*. The relevant safety demonstration requires identifying accident sequences potentially leading to such unacceptable releases and then bringing the appropriate justification that those accident sequences do not need to be considered in the plant design under the Defence-in-depth* concept. B - Identification of such accident sequences should be based on deterministic analyses, supported by engineering judgment, and probabilistic assessment. Accident sequences involving at least the following phenomena shall be demonstrated to be Practically Eliminated*: • Hydrogen detonation; • Large steam explosion; • Direct containment heating; • Large reactivity insertion (including heterogeneous boron dilution in PWRs); • Rupture at high pressure of major pressure retaining components e.g. Reactor Pressure Vessel* and large components of RCS; • Fuel failure in a spent fuel store; • Primary Containment* failure by over pressurisation; • Late containment failure due to base mat melt through; • Severe Accidents* challenging the Containment System* at all times when loss of confinement is caused by containment bypass (e.g. rupture of a steam generator tube for PWR, containment isolation valves are open or an interfacing system LOCA); and • Severe Accidents* in the shutdown state whilst the containment is open or Severe Accident* mitigating measures are out of service. C - Demonstration of Practically Eliminated* sequences should show sufficient knowledge of the scenario analysed and of the phenomena involved, substantiated by relevant evidence and associated analyses. The safety justification has to be adapted to each particular situation. Both deterministic and probabilistic arguments can be used to support the demonstration that the safety objective is reached. According to the strategy implemented in the plant design and the nature and importance of the engineered provisions dedicated to each of those particular situations, the relevant safety demonstration shall be provided: • By demonstrating the “Physical Impossibility” of the accident sequence to occur based on the sole dedicated engineered provisions; or • By demonstrating that the accident sequence is “Extremely Unlikely” to occur with a high degree of confidence.

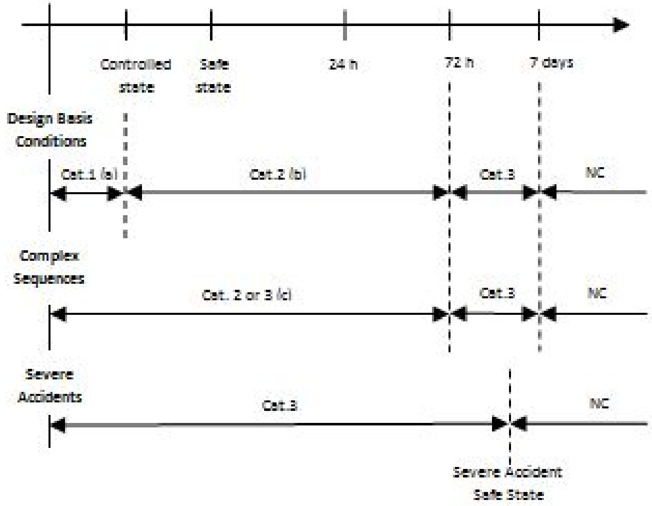
KI n°	Topic	Section Requirement	Text of the Key Issues
KI 6	**External Hazards - Identification for Standard Design**	**2.1.2.6.2.1 A-B**	A - The list of External Hazards* given in Section 2.1.9.3.1 shall be considered in the Standard Design*. Two levels of severity are defined for the relevant External Hazards*: the Design Basis External Hazard* level (DBEH) and in addition Rare and Severe External Hazard* level (RSEH). B - The Designer* shall demonstrate that the plant is designed to withstand the DBEH and RSEH levels defined for a Standard European Site* with the corresponding rules.
	External Hazards - Design Rules	**2.1.2.6.4 A-B-C-D-E-F-H**	A - The External Hazards* that could arise for a plant shall be addressed in the safety assessment, and it shall be proved that an adequate level of protection against their consequences is provided. B - External Hazards* considered at the DBEH level shall not lead to a core melt accident and their radiological consequences shall meet the safety objectives for accidents without core melt (see Section 2.1.3.3 in KI8). C - The safety assessment for DBEH shall be sufficiently conservative (similarly to safety assessment of Design Basis Accidents*). D - Simultaneous postulated occurrence of DBEH and Internal hazards* or maintenance shall be considered. E - External Hazards* considered at the RSEH level shall meet the safety objectives for accidents with core melt (see Section 2.1.3.4 in KI 8). F - The safety assessment for RSEH should be performed using realistic approach and best estimate rules (similarly to safety assessment of Design Extension Conditions*). H - The risk from External Hazards* shall be commensurate with the probabilistic safety targets (Core Damage* and/or Large Releases* or Early Releases* from reactor or fuel storage) (see Section 2.1.3.5 in KI 8).

<table>
<tr><th>KI n°</th><th>Topic</th><th>Section Requirement</th><th>Text of the Key Issues</th></tr>
<tr><td></td><td>**External Hazards**
-
List of External Hazards for Standard Design</td><td>**2.1.9.3.1**
B-C</td><td>
B

<table>
<tr><th>Natural External Hazard</th><th>Design Basis External Hazard level</th><th>Rare and Severe External Hazard level</th></tr>
<tr><td>Earthquake</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Extreme rainfall</td><td>Yes</td><td>Yes</td></tr>
<tr><td>External flooding</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Extremes of air temperatures & humidity</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Extremes of heat sink temperatures (drought)</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Extreme wind</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Tornadoes and associated missiles</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Lightning</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Snow</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Heat sink clogging by Biological phenomena (seaweeds, fish, marine growth)</td><td>Yes</td><td>No</td></tr>
</table>
C

<table>
<tr><th colspan="2">External Human made Hazard (non natural phenomenon) to be considered for Design Basis at Standard Design phase</th></tr>
<tr><td>Accidental aircraft crash,</td><td>Yes</td></tr>
<tr><td>External explosions</td><td>Yes</td></tr>
<tr><td>Heat sink clogging by oil spill</td><td>Yes</td></tr>
</table>
</td></tr>
</table>

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 7	**Doses to the Public during Normal Operation and AOOs**	**2.1.3.2.2 A-B**	A - The target for public exposure during Normal Operation* and Anticipated Operational Occurrences* shall be 0,3mSv/year per Site*. This target is independent from plant Rated Power*. The value of 0,3 mSv represents an objective of performance in line with ALARA concept. B - The methodology used by the Designer* for assessing the doses to the public in Normal Operation* and Anticipated Operational Occurrences* shall take into consideration all the possible pathways (ingestion, inhalation, deposit, direct radiation) and be applied to the most sensitive population
	Operational Staff Doses during Normal Operation and AOOs	**2.1.3.2.3 A-B-C-D**	A - The Plant Designer* shall demonstrate that for the operational staff, the following objectives for annual effective doses, including doses due to all relevant activities like maintenance, repairs, equipment changes, refuelling, In-Service Inspections, etc. can be met. B - Individual effective dose target shall be 5 mSv/year The value of 5 mSv represents an objective of performance in line with ALARA concept. C - Individual effective doses shall comply with local regulations, if these are more stringent. D - The collective effective dose: • The collective effective dose shall be ALARA; and • The target for annual collective effective dose averaged over the plant life is 0,5 man Sv per Unit*.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 8	**Safety Objectives** **-** **Off-Site radiological release targets for Accidents without core melt**	**2.1.3.3** **A-B**	A - The following safety objectives shall be met for accidents without core melt: - No Evacuation Action; - No Sheltering Action; and - No Iodine Prophylaxis Action. B - The releases resulting from any Design Basis Accidents* or Complex Sequences* shall not exceed the radiological release targets for accident without core melt, following a conservative approach. The targets depend on the category of the accident as determined by the estimated frequency of the Postulated Initiating Event*. EUR Radiological Release Targets for no or minor off-site radiological impact beyond 800 m from the reactor that shall be met by the Designer* correspond to the following limits of public exposure (derived from the safety objectives of requirement 2.1.3.3A): - Acceptance dose for Design Basis Category 3* < 1 mSv; - Acceptance dose for Design Basis Category 4* < 5 mSv; and - Acceptance dose for Complex sequence < 10 mSv. The Designer* shall provide arguments in order to demonstrate the compliance with the safety objectives defined in requirement 2.1.3.3 A. These arguments can be based on the EUR methodology targets and/or on other specific evidences to be provided by the designer including releases values into the environment.
	Safety Objectives **-** **Off-Site radiological release targets for Accidents with core melt**	**2.1.3.4** **A-B-E**	A - The following safety objectives shall be met for accidents with core melt: - No Evacuation Action* beyond 3 km from the reactor; - No Sheltering Action* beyond 5 km from the reactor; - No Iodine Prophylaxis Action* beyond 5 km from the reactor; - No permanent relocation at any distance; and - No long term restriction in food consumption after the first year following the accident beyond the sheltering zone (5 km). B - The EUR radiological release targets for the Severe Accidents* that shall be met by the Designer* correspond to the Criteria for Limited Impact* associated with the following limited consequences to the public (derived from the safety objectives of requirement 2.1.3.4.A): - Acceptance doses for Evacuation Action* < 50 mSv (7 days of exposure time); - Acceptance doses for Sheltering Action* < 10 mSv (48 hours of exposure time); - Acceptance doses for Iodine Prophylaxis Action* < 10 mSv (from iodine exposure); and - Acceptance doses for Long Term Actions < 100 mSv (50 years after termination of the releases).

KI n°	Topic	Section Requirement	Text of the Key Issues
			E - The Designer* shall provide arguments in order to demonstrate the compliance with the safety objectives defined in requirement 2.1.3.4 A. These arguments can be based on the EUR methodology targets and/or on other specific evidences to be provided by the designer including releases values into the environment.
	Safety Objectives - Probabilistic safety targets	**2.1.3.5 A - A.A - A.B - A.C**	A - EUR sets probabilistic quantitative design targets as follows: A.A - Cumulative Core Damage* frequency (CDF) shall be lower than 10^{-5} per reactor year; A.B - Cumulative frequency of accident sequences slightly exceeding the Criteria for Limited Impact* shall be lower than 10^{-6} per reactor year; and A.C - Sequences potentially involving the early or delayed failure of the Primary Containment* leading to Large Releases* or Early Releases* shall have a cumulative frequency well below the previous target of 10^{-6} per reactor year.
KI 9	**Categorisation of Safety Functions and Classification of SSCs**	**2.1.5.1.1 A-B-C**	A - The safety categorisation and classification shall be carried out by the Designer* on the following basis: • Definition of all functions required for fulfilling Fundamental Safety Functions* for all Plant States* during the lifetime of a nuclear power plant; • Categorisation of functions in accordance with their safety significance; • Identification of SSCs involved in each function; • Assignment of each SSC to a Safety Class*, according to the highest safety category of the function it has to perform; and • Definition of a set of engineering design rules and requirements proportional to the safety classification of the SSCs. B - If the Designer* has developed a different safety classification approach than the one required in Section 2.1.5.1.2 in KI 10, the Designer* shall demonstrate the equivalence of its safety classification system with the EUR safety classification principles. C - Classification of SSCs shall be based primarily on deterministic methods, complemented, where appropriate, with probabilistic methods and engineering judgment.

KI 10	**Safety Classification - Categories of Safety Functions**	**2.1.5.1.2 A-B-C**	A - Each Safety Function* shall be assigned to one of three safety categories. B - Safety Functions* shall be identified and categorised for all Plant States*, including all modes of normal operation, fault scenarios and hazard conditions, during the lifetime of a nuclear power plant. The categorisation of Safety Functions* shall take into account the following factors of safety significance: - The consequences of failure to perform the function; - The frequency of occurrence of the Postulated Initiating Event* for which the function will be called upon; and - The significance of the contribution of the function in reaching and maintaining either a Controlled State* or a Safe State*. According to the above criteria and taking into account the definitions of Plant States* the following categories of functions shall be applied. C - The significance of the contribution of the function in reaching and maintaining either a Controlled State* or a Safe State* should be informed by the timescale within which the safety function is required to perform as follows:  *(a) Cat.2 functions can be credited if it is demonstrated that the consequences of their failure are of "medium severity".* *(b) Cat.3 functions can be credited if it is demonstrated that the consequences of their failure are of "medium severity".* *(c) Cat.2 if the function is designed to provide a backup of a Cat.1 function; Cat.3 in other cases.*

<table>
<tr><th>KI n°</th><th>Topic</th><th>Section Requirement</th><th>Text of the Key Issues</th></tr>
<tr><td></td><td>Safety Classification
-
Design Provisions</td><td>2.1.5.1.3
A-B</td><td>A - The Designer* shall identify Design Provisions specifically designed for use in Normal Operation* and on the reliability of which plant safety is highly dependent.
B - Design provisions shall be directly classified according to the severity of consequences of their failures.
● Safety class 1 - Any SSC whose failure would lead to consequences of “high” severity;
● Safety class 2 - Any SSC whose failure would lead to consequences of “medium” severity;
● Safety class 3 - Any SSC whose failure would lead to consequences of “low” severity.</td></tr>
<tr><td></td><td>Safety Classification
-
Requirements on SSCs according to Safety Class</td><td>2.1.5.1.5
B-C</td><td>B - The engineering design rules and requirements shall ensure that the SSCs will be designed, manufactured, constructed, installed, commissioned, operated, tested, inspected and maintained to appropriate quality standards. These engineering design rules and requirements shall be proportionate to the SSC Safety Class* to ensure that the appropriate level of quality and reliability is achieved. These rules and requirements shall be justified by the Designer*.
C - The design rules and requirements for classified SSCs shall be informed by the level of Defence in Depth* (See Section 2.1.1.4 in KI 1) they support. Typical design requirements for classified systems and components are outlined below:
<table>
<tr><th rowspan="2">Design Requirement</th><th colspan="3">Safety Class of system</th></tr>
<tr><th>1</th><th>2</th><th>3 (c)</th></tr>
<tr><td>Single Failure Criterion</td><td>Yes</td><td>Yes (a)</td><td>No (d)</td></tr>
<tr><td>Physical & electrical Separation</td><td>Yes</td><td>Yes (b)</td><td>Yes for redundant equipment only</td></tr>
<tr><td>Emergency power supply</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Periodic tests</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
</table>
<i>a) This requirement is not applied to systems identified to support DEC scenarios and designed as a backup of a safety class 1 system which provides an alternative means to accomplish the same safety function as that performed by the safety class 1 system. The reliability of such system should be adequate to meet the total Core Damage* frequency (CDF) target.</i></td></tr>
</table>

KI n°	Topic	Section Requirement	Text of the Key Issues
			However, I&C systems designed as a backup to safety class 1 I&C systems may require the redundancy to be applied to prevent spurious actuation (e.g. for the Diverse Actuation System) b) *This requirement is only applicable to safety class 2 systems which are:* • *Required to reach and maintain the Safe State*; or* • *Required in DEC scenarios and identified as a backup of a system assigned in safety class 1.* c) *The requirements for safety class 3 systems which are not required to meet the acceptance criteria established for DBAs or DECs but are important to safety shall be determined based on specific functional analysis.* d) *Compliance with the single failure criterion is not required in DEC. However, active components may require redundancy to achieve the reliability expected for the function performed by the system (e.g. active components of systems required to preserve the containment integrity in case of a Severe Accident* with core melt*
	Safety Classification - Environmental conditions resistance levels	**2.1.5.1.7 A** **2.1.5.1.7.1 A**	A - All safety classified SSCs shall be designed, constructed and, where appropriate, qualified to withstand the effects of the hazards and environmental conditions which the SSCs will be exposed to and during and after which they are required to maintain their categorised Safety Functions*. A - Requirements for hazards and environmental conditions resistance shall be assigned to SSCs in a systematic and consistent manner taking into account their role during and after a hazard and/or DBC 2-4 and DEC, thus their safety significance.
KI 11	**Autonomy Objectives**	**2.1.6.7.1 B-C** **2.1.6.7.2 A** **2.1.6.7.3 A-B-E-F-G**	B - The plant shall be designed in such a way that it meets the following autonomy objectives: the release targets of AOOs and Accident Conditions* shall be met without Operator* action in the MCR during the first 30 minutes from the first significant signal, and no action outside the MCR during the first hour (from the first significant signal). C - In addition, the Containment System* shall be designed in such a way that it can withstand any of the Severe Accidents* considered in DEC, without Operator* action during the first 12 hours from the beginning of the Severe Accident*. The Designer* should aim at extending this period up to 24 hours. A - The design shall ensure heat removal under all Operational States*, Accident Conditions*, Design Basis External Hazards* and Rare and Severe External Hazards* for 7 days without off-site support for each Unit*. A - The plant shall be independent from the off-site electrical power supplies at least for 7 days in all Plant States* and Rare and Severe External Hazards*. B - Fuel and lubrication reserves for power supply shall have sufficient capacity to ensure 7 days autonomy of each Unit* without interconnections between the Units*.

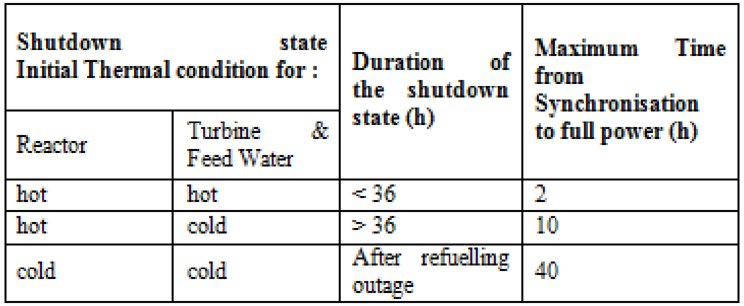
KI n°	Topic	Section Requirement	Text of the Key Issues
			E - The batteries which perform Safety Functions* following any DBA and Complex Sequences* shall be sized so that they will ensure continued operation of necessary Safety Systems* and I&C until AC power is restored. F - The batteries which perform Safety Functions* following any DBA and Complex Sequences* shall be sized so that their expected autonomy is at least 2 hours without recharging and without load shedding. G - The batteries for Severe Accidents* shall be sized so that their expected autonomy is at least 24 hours, such that they ensure continuity of power for monitoring the key plant parameters and ensure operation of severe accident mitigation measures.
KI 12	**On-site and off-site Non-Permanent Equipment**	**2.1.6.8.3 A-B-C-E**	A - The Designer* shall provide a complete list of all on-site Non-Permanent Equipment* which will be needed to maintain the long term Safe State* in situation following Design Basis Accidents* or Complex Sequences* after 72 hours. B - The Designer* shall provide a complete list of all on-site Non-Permanent Equipment* which are credited to maintain the long term Safe State* in situation following Complex Sequences*. C - The Designer* shall provide a complete list of all on-site Non-Permanent Equipment* which will be credited to reach and maintain Severe Accident Safe State* in Severe Accident*. E - On site Non-Permanent Equipment* shall be designed such that its function can be reached after a DBEH and RSEH. Its design shall comply with the codes, standards and regulations specified in KI 30.
		2.1.6.8.4 A	A - The Designer* shall provide a complete list of all off-site Non-Permanent Equipment* needed after 7 days for Design Basis Accidents*, Complex Sequences* and Severe Accidents*.
		2.1.6.8.5 C	C - The design shall at least have the provisions for Non-Permanent Equipment* which enable the use of existing safety equipment to: • Restore the necessary electrical power supply; • Restore the containment cooling; and • Assure SFP cooling and inventory.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 13	**Performance of Fuel Elements and Assemblies and Structural Capability of the Reactor Core**	**2.1.7.1.1.1 A**	A - In Normal Operation*, fuel rods should operate well below specified fuel design limits.
		2.1.7.1.1.2 A.A - B	A.A - In AOOs, the minimum Departure from Nucleate Boiling (Ratio) (DNB(R)) for PWRs shall be such as to provide at least a 95% probability, with 95% confidence that Departure from Nucleate Boiling (DNB) does not occur on any fuel rod surface. B - For BWRs, the minimum Critical Power Ratio (CPR) shall be specified such that at least 99.9% of the fuel rods in the core will not be subjected to transition boiling during the most severe Anticipated Operational Occurrences*.
		2.1.7.1.1.3 A-B-C	A - The amount of fuel rods experiencing DNB or CPR in any Design Basis Category 3* shall remain lower than 5%. B - The amount of fuel rods experiencing DNB or CPR in any Design Basis Category 4* shall remain lower than 10%. C - The core geometry shall be maintained in any Design Basis Category 4* in order to not endanger the core coolability.
		2.1.7.1.2 A	A - The fuel elements and fuel assemblies and their supporting structures shall be designed so that, in Operational States*, in Design Basis Accidents* and Complex Sequences* and under seismic conditions, a geometry that allows for adequate cooling is maintained and the insertion of control rods is not impeded.
KI 14	**Containment Bypass Accidents**	**2.1.7.3.2.1 A-B-C**	A - Containment Bypass Accidents* without fuel melting, but with potential for direct releases of primary coolant outside the Primary Containment*, shall be assessed. B - The effectiveness and means to reduce the probability of Containment Bypass Accidents* shall be assessed taking at least into consideration: • Provision of adequate margins of strength in systems that may be connected to the RCS (e.g. residual heat removal system, if located outside the Primary Containment*); • Minimisation of penetrations through the Primary Containment*; • Provision of adequate reliability and Redundancy* of valves in pipework connected to the RCS which also penetrates the Primary Containment*; and • For PWRs, provision of reliable safeguards to minimise releases in the case of SGTR. These should aim to prevent lifting of safety and relief valves associated with the affected Steam Generator* and to simplify operation of Operator* actions required to control the ensuing transient. C - For PWRs, the rupture of more than one Steam Generator* tube shall be assumed deterministically. However, the number of tubes to be considered and the related assumptions for the analysis shall be adopted on the basis of realistically postulated mechanisms,

KI n°	Topic	Section Requirement	Text of the Key Issues
			best estimate evaluations and probabilistic arguments. The design shall provide ~~for~~ means for limiting coolant discharges to the environment in case of primary-to-secondary leaks.
KI 15	**Main Control Room and Emergency Control Room**	**2.1.7.4.6 A-B-C-D**	A - A Main Control Room* shall be provided at the nuclear power plant from which the plant can be safely operated in Normal Operation* either automatically or manually, and from which measures can be taken to maintain the plant in a Safe State* or to bring it back into a Safe State* after Anticipated Operational Occurrences* and Accident Conditions*. B - Appropriate measures shall be taken, including the provision of barriers between the Main Control Room* and the external environment, and adequate information shall be provided for the protection of occupants of the Main Control Room*, for a protracted period of time, against hazards such as high radiation levels resulting from Accident Conditions*, release of radioactive material, fire, or explosive or toxic gases. C - Special attention shall be paid to identifying those events, both internal and external to the Main Control Room* that could challenge its continued operation, and the design shall provide for reasonably practicable measures to minimise the consequences of such events. D - The design of the Main Control Room* shall provide an adequate margin against levels of Rare and Severe External Hazards* taking into account the site hazard evaluation.
		2.1.7.4.7 A-B	A - Instrumentation and control equipment shall be available, preferably at a single location (Emergency Control Room*) that is physically, electrically and functionally separate from the Main Control Room*. B - The Emergency Control Room* shall be sufficiently equipped so that the reactor can be placed and maintained in a shutdown state, residual heat can be removed from reactor and from the spent fuel storage, and essential plant variables can be monitored if there is a loss of ability to perform these essential safety functions from the Main Control Room*.
KI 16	**Electrical Power Supply in AOOs and Accident Conditions**	**2.1.7.5 A-B-E-F-G**	A - The design shall include an Emergency Power Supply* capable of supplying the necessary power in Anticipated Operational Occurrences* and Design Basis Accidents*, in the event of the LOOP. The design shall include an Alternate Power Source* to supply the necessary power in Design Extension Conditions*. B - The design specifications for the Emergency Power Supply* and for the Alternate Power Source* shall include the requirements for capability, availability, duration of the required power supply, capacity and continuity. E - The Alternate Power Source* shall be capable of supplying the necessary power to preserve the integrity of the Reactor Coolant System* and to prevent Core Damage* and to ensure spent fuel cooling in the event of Station Blackout*.

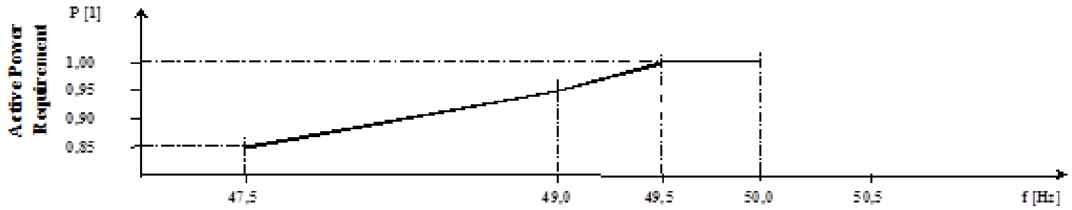
KI n°	Topic	Section Requirement	Text of the Key Issues
			F - The Alternate Power Source* shall be independent of and physically separated from the Emergency Power Supply*. The connection time of the Alternate Power Source* shall be consistent with the depletion time of the batteries (e.g. 2 hours depending on battery capacity). G - Alternate Power Source* shall have sufficient capacity to support at the same time all these functions: remove decay heat from core and spent fuel store, ensure primary circuit integrity, maintain reactor and spent fuel store sub-criticality and monitor the state of the Unit*.
KI 17	**Fuel Storage and Handling system**	**2.1.7.7 A**	A - Fuel storage and handling systems (FSHS) shall be provided at the plant to ensure that: • The integrity and properties of the fuel are maintained at all times during fuel storage and handling in Normal Operation* and Anticipated Operational Occurrences*; and • Sub-criticality is ensured and sustained for fuel storage during all Plant States*.
		2.1.7.7.1 A-B-C-D-E	A - The design of spent fuel store shall be such as to prevent the uncovering of Fuel Assemblies* in all Plant States* that are of relevance for the spent fuel pool, so as to practically eliminate the possibility of Early Release* or Large Release* and to avoid high radiation field on Site*. B - The design shall: • Provide the necessary fuel cooling capabilities; • Provide features to prevent the uncovering of fuel assemblies in the event of a leak, fuel pool draining or a pipe break; and • Provide a capability to restore the water inventory. C - The spent fuel pool structural integrity shall be maintained against Rare and Severe External Hazards*. D - Spent fuel pools shall be designed to maintain a large inventory of coolant to protect and cool the fuel in Complex Sequences*. E - The design shall provide redundant lines for spent pool cooling that eliminate the possibility of loss of cooling function.

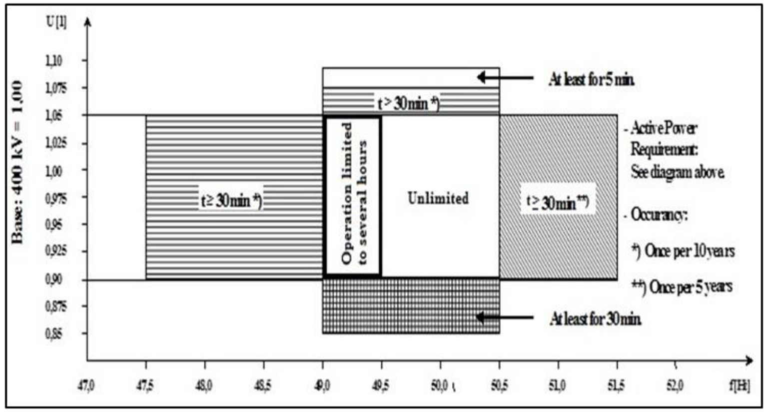
KI n°	Topic	Section Requirement	Text of the Key Issues
	Stored Fuel Heat Removal	**2.8.2.2.2.1 F-I**	F - The sizing of SFP inventory and design of FPCS shall be consistent with autonomy objectives of Section 2.1.6.7.3 in KI 11 even in the event of total loss of cooling or make-up control. I - The SFP design shall include the following: • Means for monitoring and controlling the water temperature for Operational States *and for Accident Conditions* that are of relevance for the spent fuel pool; • Means for monitoring and controlling the water level for Operational States* and for Accident Conditions* that are of relevance for the spent fuel pool; • Means for monitoring and controlling the activity in water and in air for Operational States* and means for monitoring the activity in water and in air for Accident Conditions* that are of relevance for the spent fuel pool; and • Means for monitoring and controlling the water chemistry for Operational States*.
KI 18	**Intentional Aircraft Crash**	**2.1.8.3.3 A-B-D-E-F**	A - Intentional aircraft crash is an extreme event which can only happen if several security defence layers have been breached. A probabilistic approach for this Hazard* is subjective and unrealistic. Therefore a deterministic approach is required. This event should be considered in the design but with best estimate design Rules* and radiological consequences associated with Complex Sequences*. B - The intentional airplane crash shall be characterised by load/time curves. The selection of these curves shall take into account the national regulatory requirements. D - Direct and indirect effects of the aircraft crash shall be considered, in particular: • Effects of direct and secondary impacts on mechanical resistance of Items Important to Safety required to bring and maintain the plant in a Safe State* after aircraft crash; • Effects of vibrations on safety structures and systems required to bring and maintain the plant in a Safe State* after aircraft crash; and • Effects of combustion and/or explosion of aircraft fuel on the integrity of the necessary structures and systems required to bring and maintain the plant in a Safe State* after aircraft crash. E - Buildings containing nuclear fuel and housing key Safety Functions* should be designed to prevent aircraft fuel from entering these buildings. Fires caused by aircraft fuel shall be assessed as different kinds of fire ball and pool fire combinations. Other consequential fires due to the aircraft crash shall be addressed. F - An intentional aircraft crash shall not lead to core melt. Releases of radioactive materials should meet the safety objectives and radiological release targets for Complex Sequences*.

<table>
<tr><th>KI n°</th><th>Topic</th><th>Section Requirement</th><th>Text of the Key Issues</th></tr>
<tr><td>KI 19</td><td>Duration of Cooldown</td><td>2.2.2.1.1
A-B</td><td>A - The plant should be capable of shutdown from Hot Zero Power* to Cold Shutdown Mode* at a temperature less than 60°C within 16 hours and the cooling period shall be no longer than 24 hours.
B - The removal of the Reactor Pressure Vessel* (RPV) head shall be achieved within:
• 32 hours after reactor trip for BWR; or
• 72 hours after reactor trip for PWR.</td></tr>
<tr><td>KI 20</td><td>Duration of Start-up and Loading</td><td>2.2.2.1.2
B-C</td><td>B - The duration of the phase from Hot Shutdown Mode* to synchronisation to the grid, including physical tests and criticality shall be less than 24 hours.
C - The Designer* shall specify the loading times from synchronisation to full power after short shutdown (< 36 h), after long shutdown (> 36 h) and after refuelling outage. The maximum time of this loading phase, including physical tests, shall be as follows:

<table>
<tr><th colspan="2">Shutdown state Initial Thermal condition for :</th><th rowspan="2">Duration of the shutdown state (h)</th><th rowspan="2">Maximum Time from Synchronisation to full power (h)</th></tr>
<tr><th>Reactor</th><th>Turbine & Feed Water</th></tr>
<tr><td>hot</td><td>hot</td><td>< 36</td><td>2</td></tr>
<tr><td>hot</td><td>cold</td><td>> 36</td><td>10</td></tr>
<tr><td>cold</td><td>cold</td><td>After refuelling outage</td><td>40</td></tr>
</table></td></tr>
<tr><td>KI 21</td><td>Type of Fuel, Refuelling Cycle and Expected Thermal Margins</td><td>2.2.3.1
A-B
2.2.3.4.1
A (1)</td><td>A - The core design shall be optimised for UO_2 Fuel Assemblies*.
B - However, provisions shall be made to allow the use of up to 30% standard MOX Fuel Assemblies* in the core, the remainder being UO_2 assemblies.
A - The design of the core shall be capable of producing its Rated Power* taking into account:
• 100% UO_2 or 30% MOX cores, both of them with refuelling intervals corresponding to Section 2.2.3.2, and with a fuel burn-ups of discharged assemblies achieving targets indicated in Section 2.2.4.1 in KI 32 for MOX and UO2.</td></tr>
</table>

KI n°	Topic	Section Requirement	Text of the Key Issues
		2.8.2.2.1.1 A	A - Fuel storage and handling functions shall be ensured in accordance with the requirements on fuel burn-up (Section 2.2.4.1 in KI 32), MOX percentage (Section 2.2.3.1) and storage capacity (Section 2.2.5.1 in KI 24).
		2.2.3.2 A	A - The core design shall allow the flexibility of operating on fuel cycles with refuelling intervals from 12 months up to 24 months, assuming Refuelling-only Outage*.
KI 22	**Low Boron Capability**	**2.2.3.7 B**	B - The core shall be designed with sufficient insertable negative reactivity to ensure that soluble boron concentration change is not required to control core power during Design Basis Conditions 1* (Normal Operation*) (PWR only).
		2.2.3.5 A	A - The power reactivity coefficient shall be negative under all Design Basis Conditions* and Design Extension Conditions*.
KI 23	**Load Following and Manoeuvring Capability**	**2.2.3.4.1 A (2)**	A - The design of the core shall be capable of producing its Rated Power* taking into account: • Capability for power distribution control, Load Following*, stretch-out and coast-down.
		2.2.3.8 A	A - The core shall be designed to perform scheduled Load Following* and unscheduled load variations operation during 90 % of the whole fuel cycle.

<table>
<tr><th>KI n°</th><th>Topic</th><th>Section Requirement</th><th>Text of the Key Issues</th></tr>
<tr><td>KI 24</td><td>Spent Fuel Storage Capacity</td><td>2.2.5.1
A</td><td>A - The total capacity of the spent fuel pool(s) or storage should be at least A + B + C + D cells, according to the following Table:
<table><tr><td>Room for spent UO_2 assemblies</td><td>10 years of production (1), (2), (4)</td><td>A cells</td></tr><tr><td>Room for spent MOX assemblies</td><td>15 years of production (1), (3), (4)</td><td>B cells</td></tr><tr><td>Room for core unloading</td><td>1 full core</td><td>C cells</td></tr><tr><td>Rooms for various irradiated equipment</td><td>(5)</td><td>D cells</td></tr><tr><td>Total capacity</td><td></td><td>A + B + C + D cells</td></tr></table>
(1) <i>The core is supposed to be operated continuously with 70% of UO2 assemblies and 30% of MOX assemblies with the availability performance stated in KI 25.</i>
(2) <i>The number of unloaded UO2 assemblies is to be assessed considering an average assembly burn up equal to 55 MWd/kgHM.</i>
(3) <i>The number of unloaded MOX assemblies is to be assessed considering an average assembly burn up equal to 40 MWd/kgHM.</i>
(4) <i>A-cells also include one reload of fresh fuel.</i>
(5) <i>These cells include space for:</i>
• <i>absorbers;</i>
• <i>a full set of control rods;</i>
• <i>damaged fuel assemblies and/or rods (special features are to be foreseen, e.g. canisters or racks to minimise dispersion of fuel fragments or fission products); and</i>
• <i>other irradiated equipment (e.g. in-core detectors, etc.).</i></td></tr>
</table>

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 25	**Overall Availability, Outage Duration**	**2.2.7.2.1 A**	A - As a design objective, the average annual Design Availability Factor* shall be greater than 90% for a fuel cycle length equal to, or longer than 12 months.
		2.2.7.2.2 B - B.A - B.B - B.C	B - The Planned Outages* should be completed (breaker-to-breaker) in less than: B.A - 16 calendar days for refuelling and regular maintenance outages; B.B - 24 calendar days for a main turbine-generator overhaul; and B.C - 36 calendar days for an In-Service-Inspection Outage*.
KI 26	**Response to Loss of External Grid**	**2.2.2.11 A**	A - The plant shall be able to cope with loss of external grid by switching to house load operation without reactor trip.
KI 27	**Grid Interface**	**2.2.2.8 A**	A - The Standard Plant* design shall allow the implementation of a Secondary Control of Grid Supply*.
		2.3.2.2.1 A	A - The rated frequency shall be 50 Hz.
		2.3.2.2.2 A - B	A and B - The Unit* shall remain connected and shall be able to operate within the limits defined in the following Figures. *Explanation for U: Ur = 1.00 corresponds to nominal connection voltage agreed with the Transmission System Operator (TSO).* *These Figures are valid in quasi-steady conditions of voltage and frequency, i.e. the rate of change of voltage and frequency, or voltage and frequency simultaneously is within the following limits:* *Voltage ≤ 5%/min; and* *Frequency ≤ 0.5 %/min*  The related active power belongs to the voltage-frequency-areas shown below. **Figure: Maximum active power on frequency range of operation**

KI n°	Topic	Section Requirement	Text of the Key Issues
			 **Figure: Voltage Frequency Level**
		2.3.3.1.2 A	A - Frequency Sensitive Mode (FSM) means the operating mode of a Unit* in which the active power output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency. As required in the European Code "Requirements for Generators" (RfG), the Unit* shall be capable of activating the provision of active power frequency response in FSM according to the parameters specified by the relevant TSO.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 28	**Plant Design Life**	**2.4.2 A-C (C.A to C.D; C.F, C.G, C.H) E**	A - The plant shall be designed for a lifetime of 60 years. C - The design of the plant shall be optimised in order to meet this plant lifetime requirement. This optimisation will take into consideration the following: CA - All major plant components and equipment which are not replaceable shall be expected to meet the specified design life; CB - The Designer* shall define the fluid system design transients which should represent umbrella cases for operational events postulated to occur during the plant Design Lifetime*; CC - These transients should be considered to be such magnitude and/or frequency to be significant in the component design and fatigue evaluation process; CD - Pertinent variations in the fluid pressure, temperature and flow should be determined by associated transient analyses and used to describe the transients from the component design point of view; CF - There shall be a plan for replacement of those components which may be subject to obsolescence, or to avoid early failure due to fatigue; CG - This plan for replacement, refurbishment or repair shall ensure that the design life of the plant is achieved at minimum cost and will be submitted to the Owner* for early approval; and CH - Where appropriate, provision shall be made to allow Inspection*, maintenance and replacement of seals between different buildings. E - For the Reactor Vessel* and all major structures which are not replaceable, such as the containment, the Designer* shall present the margins for Design Lifetime* longer than 60 years.

<table>
<tr><th>KI n°</th><th>Topic</th><th>Section Requirement</th><th>Text of the Key Issues</th></tr>
<tr><td rowspan="2">KI 29</td><td>Seismic Design Levels</td><td>2.4.1.2.1.3
A-B</td><td>A - The Design Basis External Hazards* (DBEH) value of seismic design level (Peak Ground Acceleration at ground level) to be considered in the Standard Design* shall be as follow:
• Design Basis Earthquake* (DBE) level = 0,25 g (value is associated with three ground motion response spectra).
B - The Rare and Severe External Hazards* (RSEH) value to be considered in the Standard Design* shall be as follow:
• RSEH earthquake level =1,5*DBEH = 0,375 g.</td></tr>
<tr><td>Soil Properties for Seismic Analysis</td><td>2.4.6.4.2
A-B-C
2.4.6.4.2.1
A</td><td>A - The founding medium shall be treated as an elastic isotropic homogeneous half space.
B - The Table of the mechanical properties given in the following Section 2.4.6.4.2.1 shall be used in the analysis.
C - Based on this Table, nine typical sites are identified, three in each site category: soft, medium and hard. The ground motion spectra, associated with the three site categories, shall therefore each be used for three identified sites.
<table>
<tr><th>Type of Spectrum</th><th colspan="3">Soft</th><th colspan="3">Medium</th><th colspan="3">Hard</th></tr>
<tr><td>1. Shear wave velocity (m/s)</td><td>250</td><td>350</td><td>500</td><td>600</td><td>800</td><td>1 100</td><td>1 200</td><td>1 700</td><td>2 500</td></tr>
<tr><td>2. Mass density (kg/m³)</td><td colspan="3">2 000</td><td colspan="3">2 200</td><td colspan="3">2 500</td></tr>
<tr><td>3. Poisson's ratio</td><td colspan="3">0,47</td><td colspan="3">0,40</td><td colspan="3">0,35</td></tr>
<tr><td>4. Internal damping (%)</td><td colspan="3">5</td><td colspan="3">4</td><td colspan="3">3</td></tr>
<tr><td>5. Free field shear modulus Gmax (MPa)</td><td>125</td><td>245</td><td>500</td><td>792</td><td>1 408</td><td>2 662</td><td>3 600</td><td>7 225</td><td>15 625</td></tr>
<tr><td>6. Gmax beneath structures (MPa)</td><td>125</td><td>270</td><td>600</td><td>950</td><td>1 690</td><td>2 930</td><td>3 960</td><td>7 225</td><td>15 625</td></tr>
<tr><td>7. Effective G beneath structures (MPa)</td><td>112,5</td><td>243</td><td>540</td><td>902,5</td><td>1605,5</td><td>2 782</td><td>3 960</td><td>7 225</td><td>15 625</td></tr>
<tr><td>8. Effective Young's modulus (MPa)</td><td>330,8</td><td>714,4</td><td>1 587,6</td><td>2 527</td><td>4 495,4</td><td>7 789</td><td>10 692</td><td>19 507,5</td><td>42 187,5</td></tr>
</table>
Table: Soil properties
A - The values assigned in line 1 are intended to give a wide range of possible site stiffness. Lines 2, 3 and 4 give values presumed to be typical of the overall site type. Line 5 values are calculated from the shear wave velocity (VS30, representing the average of the first 30 m below the foundation ground level) and Poisson's Ratio in the usual way. Line 6 indicates the change to Gmax as a consequence of the confining pressure and the shear strain beneath major structures. Line 7 indicates the consequences of the non-linearity that is assumed to occur beneath the structures, during the DBE. Finally, line 8 gives the value for the effective Young's Modulus calculated from the effective shear modulus and Poisson's Ratio in the usual way.</td></tr>
</table>

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 30	**Codes and Standards**	**2.5.2 A-B**	A - For each Standard Design*, and for each individual project, a list of applicable Rules* shall be developed. B - For a Standard Design*, the Designer* shall provide a preliminary list of the main Rules* to be included in Volume 3 and shall make the assessment of this list of Rules*, considering interferences with other EUR requirements.
		2.5.3 B	B - The proposed set of applicable Rules*, Codes and Standards* shall be consistent for each part of the design and compatible between all parts.
KI 31	**Materials Selection**	**2.6.3.2. A**	A - When selecting a material, in addition to other specific requirements for each component, the Plant Designer* shall consider aspects such as: • Mechanical properties; • Manufacturing, testing and Inspection* capabilities, including In Service Inspection (ISI) capability; and • Operating conditions and possible ageing effects/degradation.
KI 32	**Fuel Compatibility**	**2.7.11.4 A**	A - The Fuel Assembly* (FA) design shall ensure compatibility with: • The fuel channel, if any; • The associated core components; • The core internals; • The fuel handling route; • FAs from different manufacturers; and • The fuel back-end cycle, fuel storage, shipping and reprocessing.
		2.2.4.1 A	A - The mechanical design of the Fuel Assembly* shall be such that discharged fuel is capable of an average burn-up of at least: • 55 MWd/kg of heavy metals atoms (kgHM) for UO_2 fuel with a Maximum Assembly Burn-up* of at least 60 MWd/kgHM; and • 40 MWd/kgHM for MOX fuel, with a Maximum Assembly Burn-up* of at least 45 MWd/kgHM.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 33	**Diesels Generators – I&C Principles**	**2.7.13.2.2 A-B-C-D-E**	A - Diesel generators designed as Emergency Power Supply* shall be designed to start up automatically on: • Voltage or frequency drop to the emergency power bus-bar; and • Initiation of active Safety Systems*. B - Diesel generators designed as Alternate Power Source* shall be designed with automatic start up, if manual start up is not compatible with time period set for Operator* action. C - They shall also be designed for manual start up: • From the Main Control Room* (MCR); • Emergency Control Room* (ECR); and • Using local controls with adequate interlocks. This shall also include the possibility of manual start up by purely mechanical means as last resort. A slow start capability for periodic testing purposes should be provided to ensure the Design Lifetime* of diesel generators. D - Switch-over of safeguard auxiliaries shall be automatic on loss of voltage at the emergency bus-bars. E - Reconnection to the off-site source and diesel generator shutdown shall be done manually.
KI 34	**Reliability of Shutdown Capabilities & Shutdown margin**	**2.8.2.1.1.5 A-B-D**	A - Reactor shutdown shall be achievable by means of at least two independent and diverse systems. B - At least one of the two systems shall, on its own, be capable of quickly rending the nuclear reactor sub-critical by an adequate margin in all Operational States*, in Design Basis Accidents*, on the assumption of a single failure. D - The means of shutdown shall be adequate to prevent any foreseeable increase in reactivity leading to unintentional criticality during the shutdown, or during refuelling or other routine or no routine operations in the shutdown state.
		2.8.2.1.1.6 B	B - In judging the adequacy of the means of shutdown of the reactor, consideration shall be given to failures arising anywhere in the plant that could render part of the means of shutdown inoperative (such as failure of a control rod to insert) or that could result in a Common Cause Failure*.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 35	**Waste collection And generation**	**2.8.2.2.4.3 A**	A - The following functions shall be provided: • Selective collection and Segregation* of liquid and gaseous effluents produced by the RCS, nuclear auxiliary systems, Reactor Cavity* and spent fuel pool, as well as of all potentially-contaminated liquids produced in the plant (such as floor drains, laundry and decontamination waste); • Routing of the collected waste to the storage and processing facilities; and • Capability for re-injection of highly contaminated liquids from the auxiliary buildings, or Secondary Containment*, into the Primary Containment* in DBC and DEC, if the quantity of fluid exceeds the waste treatment capacity.
		2.2.5.2 A-B-C-D	A - Plant systems shall be designed so that they can be operated, maintained and repaired to minimise the generation of liquid and solid radwaste. B - Radwaste systems shall include advanced techniques of waste concentration and volume reduction. C - The total final volume of solid radwaste (wet solidified, dry compacted or non-compactable) shall be no more than 50 m^3 per 1 000 MWe plant-year of Normal Operation*. D - The Designer* shall justify the solid radwaste volume reduction techniques proposed and their guaranteed performance.
KI 36	**Reactor Cooling System Arrangement and Mid-Loop Operation**	**2.8.3.3.1.3.2 A-AA-AB-AD-AE -C**	A - The RCS and its connected systems shall be designed and laid-out to satisfy the following requirements: AA - No piping should be connected to the RPV below the Top of Active Fuel level (TAF). Nevertheless, if some small piping is located in the RPV bottom head, it shall be demonstrated that it is impossible to drain out the water down to less than TAF level during shutdown states; AB - The RCS shall be arranged in such a way that only one free surface, in the pressuriser, normally exists in the system; AD - In the case where there are of 2 or 3 SGs, the RCS arrangement shall enable the maximum expected reactor decay heat to be transferred adequately from the reactor by only one SG and by natural circulation; and AE - The RCS circuits should be designed and laid-out so that it is impossible to drain water out of the RCS below the mid-loop low level, except where it is necessary and when the core is unloaded. C - If mid-loop operation has to be used (i.e. for gas sweeping before opening the vessel), it shall be demonstrated, by the Designer*, that the functionality of residual heat removal systems is not impaired.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 37	**Independence and Separation of System Divisions**	**2.8.4.1.5 A-B-C**	A - Each Division shall be independent and separated from other Divisions* both mechanically and electrically and shall be provided with physical protection against Internal Hazards*. B - Cross-connections between Divisions* of equipment which perform Safety Functions* should be avoided unless an improvement in safety, operability or availability is demonstrated. Only very few exceptions shall be accepted based on a probabilistic safety analysis. C - Interconnections between Divisions* of different systems should be avoided.
KI 38	**Containment System General Configuration**	**2.9.2.1 A-B-C-D**	A - The Containment System* shall include a Primary Containment* and a Secondary Containment*. B - The acceptable technologies for the Primary Containment* shall be: • Metallic; • Reinforced concrete with liner; or • Concrete pre-stressed with liner. C - For the case of PWRs, the Primary Containment* shall be of the large dry type. D - For BWRs, the Primary Containment* shall be of pressure suppression type. The pressure suppression Containment System* shall limit static pressure and dynamic loads on the containment structures in all conditions considered in the design. It includes two sub-volumes: the Drywell* and the Wetwell*.
KI 39	**Secondary Containment Performance**	**2.9.2.2.1.3 A**	A - The design of the Secondary Containment* shall be effective for hold-up and deposition of fission products, if its volume is not maintained sub-atmospheric during Accident Conditions*.
		2.9.2.2.1.4 A	A - Secondary Containment Bypass* leakage should not exceed about 10% of the integrated design Primary Containment* leakage for any DBC or DEC.
KI 40	**In-Vessel & Ex-Vessel Debris Cooling**	**2.9.3.1.8.2 A**	A - The Designer* shall evaluate the possibility of corium cooling by In-Vessel Retention* (IVR).
		2.9.3.1.8.3 A-B-C	A - If the IVR is not fully demonstrated, specific provisions shall be provided to assure corium coolability outside the vessel. B - The Designer* shall prove that the corium will not jeopardise the civil structures and equipment needed for mitigation of Severe Accidents* consequences. C - Molten core-concrete interaction shall be limited to avoid basemat melt-through.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 41	**Containment Spray System Configuration**	**2.9.4.1.2.1 B**	B - The Designer* shall simplify the CSS to the maximum extent possible. In particular the Designer* shall avoid recirculation of contaminated water outside the Containment System*.
KI 42	**High-Energy Lines within the Secondary Containment**	**2.9.4.2.2 B**	B - Sections of High-energy lines* included in the Secondary Containment*, the rupture of which may produce significant pressurisation of the Secondary Containment*, either shall be provided with a double pipe to channel any energy releases from such a pipe break inside the Primary Containment* or its rupture shall be excluded by appropriate design, manufacturing and testing.
KI 43	**Overall I&C and System Life Cycle**	**2.10.6.1 A-B**	A - As stated in International Electrotechnical Commission (IEC) 61513, a systematic approach shall be adopted to ensure that all the plant requirements are met by I&C functions and systems. This is achieved by placing the activities associated with development, implementation and operation of I&C into the framework of an overall lifecycle. B - The design of the overall safety I&C shall be compliant with IEC 61513.
KI 44	**Output Documentation of I&C Requirements Specification Phase**	**2.10.6.3 B**	B - The I&C systems requirements specifications shall include, as a minimum, the following: • Each I&C function (safety and non-safety functions) is identified, defined and has a specific identifier; • The safety category of each I&C function is specified; • The DiD level for each I&C function is specified; • The reliability requirements are specified for each I&C function; • Performance parameters (like accuracy and response time) for each I&C function are specified; • For each input and output a safe state is specified; and • Each function is clearly defined both descriptively and formally in a formal language.
KI 45	**Qualification Programme**	**2.1.8.1.2 A**	A - A qualification programme for Items Important to Safety* shall be implemented to verify that Items Important to Safety* at the plant are capable of performing their intended functions when necessary, and in the prevailing environmental conditions, throughout their design life, with due account taken of plant conditions during maintenance and testing.
		2.10.7.2.2.7 A-B-C	A - Safety classified I&C systems shall be qualified in order to confirm that they are capable of meeting, throughout their operational life, the requirements for performing Safety Functions* while being subjected to the environmental conditions prior to and at the time of need. B - A Qualification plan shall be provided by the supplier (including sub plans) describing the methodology, basic principles, the applied standards and specifications, and overall approach for the Equipment Qualification*.

KI n°	Topic	Section Requirement	Text of the Key Issues
			C - For computer-based system this qualification shall include the hardware, the system software and the application software both integrated in the hardware.
		2.4.8.1.1 A-B-C	A - The Designer* shall institute a programme of seismic qualification to ensure that equipment classified as Environmental Condition Resistance Level 1 and 2 meets the prescribed performance requirements in the event of a DBE preceded or followed by an appropriate number of seismic events of a less magnitude (pre-shocks and after-shocks). B - Seismic and dynamic qualification of Environmental Condition Resistance Level 1 and 2 electrical equipment shall meet the requirements of IEC 60980, supplemented by industrial practices, where applicable, or other standards, provided they are demonstrated to be equivalent to IEC 60980 for the class of equipment involved. C - Seismic and dynamic qualification of Environmental Condition Resistance Level 1 and 2 mechanical equipment shall meet the relevant standard.
KI 46	Fire	2.11.2.4.2 A-J-K-L-N-P-Q	A - Fire Areas* and Fire Zones* shall be incorporated into the overall layout and building layouts to restrict the impact of fire on safety equipment. J - Rooms containing safety computer equipment that is not part of the control room complex shall be separated from their redundant backups and from other areas of the plant by allocation of Fire Areas*. K - The control complex shall be separated from the remainder of the plant by Fire Barriers* on the walls, ceilings and floors. L - Peripheral rooms in the control complex shall be separated from the MCR by the allocation of Fire Areas*. N - The separation of redundant systems inside the MCR shall be achieved, as far as practicable, by Fire Zones* and Barriers*. P - Allocation of Fire Areas* for redundant shutdown systems inside the Containment System* shall be achieved by distance and the risk reduced by limiting the combustible loading and providing fire detection and suppression systems designed on the basis of fire Hazards* analyses. Q - Fire Barriers* shall not impede access to safety classified equipment.
KI 47	Information Management System	2.12.12 A	A - The Designer* shall use appropriate computer hardware and software to establish, manage, and operate an Information Management System (IMS) during the design process, construction and start-up, and provide for hand-over of the IMS to the Owner* so that is available for use during plant operation.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 48	**Project time schedule optimisation**	**2.13.2.2 A**	A - The Designer* shall achieve an overall construction time as short as possible, reflecting the best investment case. The target should be an achievable documented construction programme of less than 60 months.
KI 49	**Long Term Safety**	**2.1.8.1.1 A-B**	A - Items Important to Safety* shall be designed to be calibrated, tested, maintained, repaired or replaced, inspected and monitored as required to ensure their capability of performing their functions and to maintain their integrity in all conditions specified in their design basis. B - The plant layout shall be such that activities for calibration, testing, maintenance, repair or replacement, Inspection* and monitoring are facilitated and can be performed to relevant national and international codes and standards. Such activities shall be commensurate with the importance of the Safety Functions* to be performed, and shall be performed without undue exposure of workers.
		2.1.8.1.3 A-B	A - The design life of Items Important to Safety* shall be determined. Appropriate margins shall be provided in the design to take due account of relevant mechanisms of ageing, neutron embrittlement and wear out and of the potential for age related degradation, to ensure the capability of Items Important to Safety* to perform their necessary Safety Functions* throughout their Design lifetime*. B - The design shall take due account of ageing and wear out effects in all Operational States* for which a component is credited, including testing, maintenance, maintenance outages, Plant States* during a Postulated Initiating Event* and Plant States* following a Postulated Initiating Event*.
	Provisions for Replacement of Major Components	**2.14.5 A**	A - The plant arrangement shall provide features to facilitate the replacement of all major plant components other than those considered by the Designer* not likely to require replacement during the plant's lifetime.

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KI 50	**Quality Assurance**	**2.15.1 A-E-F-M**	A - An overall Quality Assurance* Programme (QAP) for the project is a part of the management system of the Owner* for all the different stages of a plant project (e.g. siting, purchasing, design, reviewing, licensing, procurement, manufacturing, construction, factory testing, installation, commissioning tests, and operation). E - The overall QAP of the project, as well as management processes and QAPs of Contractors*, and review organisations, shall be in accordance with the requirements of the nuclear specific safety standard IAEA GSR Part 2 (2016). F - European standard EN ISO 9001 (2015) "Quality management systems - Requirements" shall also be used in the development of detailed requirements to the quality processes and procedures associated with products and services for design, purchasing, manufacturing, construction, installation, erection, testing, commissioning and operation. Where potential contradiction between ISO 9001 (2015) and IAEA GSR Part 2 (2016) exist in the implementation phase, the nuclear specific features of the IAEA GSR Part 2 (2016) standard shall be mandatory QAP input for nuclear related Structures, Systems and Components* (SSCs). M - Project specific risks and opportunities shall be properly managed within overall QAP of the Owner* and further integrated into QAPs of Contractors* in order, but not limited, to: • Assure the QAPs can achieve their intended result(s); • Assure that the Contractors* can consistently achieve conformity of products and services; • Prevent or reduce undesired results, and • Enhance desirable effects and achieve improvement.

KI n°	Topic	Section Requirement	Text of the Key Issues
KI 51	**Design for Decommissioning**	**2.16.3 J**	J - The following features are especially relevant and shall be used in the design: • Easy isolation of systems; • Systems designed with minimum interdependencies; • Easy disassembly allowing heavy component replacement; • Choice of materials, with the aim of reducing risks resulting from high dose rate in the vicinity of radioactive material, and reducing the amount of long half-life radioisotopes. Especially, materials leading to formation of ^{60}Co and ^{14}C under irradiation shall be minimised; • Achievement of good surface condition for potentially contaminated metallic components, thus facilitating subsequent possible decontamination; and • Ready accessibility and easy removal of components and internals in order: ○ to minimise the radiation exposure to the personnel; ○ to reduce the number of personnel required for Decommissioning* work; • Provision of systems to monitor and record leakage throughout the life time of the plant at strategically chosen points.
KI 52	**Probabilistic Safety Assessment (PSA)**	**2.1.4.3 A-B-C-D**	A - The design shall take due account of the PSA of the plant for all modes of operation and for all Plant States* including shutdown as well as Internal Hazards* and External Hazards*, with particular reference to: • Establishing that a balanced design has been achieved such that no particular feature or Postulated Initiating Event* makes a disproportionately large or significantly uncertain contribution to the overall risks, and that, to the extent practicable, the levels of Defence in Depth* are independent; • Providing assurance that small deviations in plant parameters that could give rise to large variations in plant conditions (Cliff Edge Effect*) shall be prevented; and • Comparing the results of the analysis with the acceptance criteria for risk where these have been specified. B - In addition, PSA shall also be used: • To determine the reliability of equipment and systems required to cope with Severe Accidents*; • To complement the deterministic approach in assessing the probability of initiating events and of events combinations; • To complement the deterministic approach in assessing Complex Sequences* to be considered as Design Extension Conditions* and addressed in the design; and

KI n°	Topic	Section Requirement	Text of the Key Issues
			• To support the definition of Technical Specifications* and emergency procedures. C - The reliability claimed for Structures, Systems and Components* shall be justified by a reliability assessment. This shall make use of reliability and availability data from reactor operating experience and other relevant sources, analysed in such a way that can be verified. D - The PSA shall take into account possible Operator* errors. Both diagnostic and procedural errors shall be accounted.
		2.17.2.1 B	B - Given the aim of the verification that the plant design complies with the probabilistic safety targets (Section 2.1.3.5 in KI 8), the scope of the PSA shall cover the assessment of the Core Damage* frequency, the evaluation of containment response and the estimation of the frequency for exceeding the Criteria for Limited Impact*.
KI 53	**Human Factor**	**2.1.8.2 C-F**	C - In the Main Control Room*, the Operator* shall be provided with clear displays of those parameters which give the Operator* a clear understanding of the current status of all equipment and systems necessary to achieve the Safety Functions* in a co-ordinated manner. Similar provisions should be made for the Emergency Control Room*. F - The human–machine interface shall be designed to provide the operators with comprehensive but easily manageable information, in accordance with the necessary decision times and action times. The information necessary for the Operator* to make a decision to act shall be simply and unambiguously presented.
		2.17.3.5 A-B	A - Human Reliability Analysis (HRA) shall be used in the PSA. B - The analysis shall at least include: • The systematic identification of human actions that are involved in the plant model. This is likely to include both qualitative and quantitative elements of analysis; • Derivation of the error probability of those human actions; • A sensitivity analysis by varying HRA parameters; probabilistic goals should be achieved also without credit to Operator* action for 30 minutes after initiating event occurs; and • A framework for further extension of HRA along with design development, procedure development, operating practices, etc.
		2.14.1.1 F	F - Human factors design principles shall be consistently applied throughout the design process for each operation or maintenance work space, in order to reduce operation and maintenance errors during all plant operating modes.