

Qualification of electrical equipment according to RCC-E

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Agenda

- A few words about AFCEN and RCC-E
- Equipment Qualification : what for ?
- Qualification preservation

A few words about AFCEN and RCC-E

What is AFCEN ?

AFCEN is an International Standard Developing Organization whose primary purpose is to:

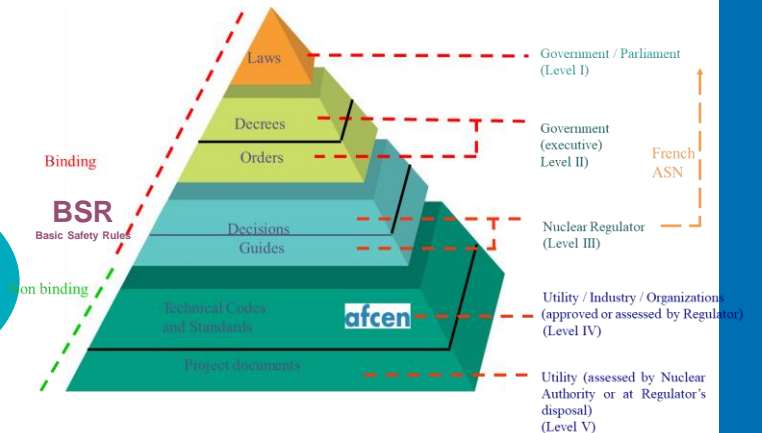
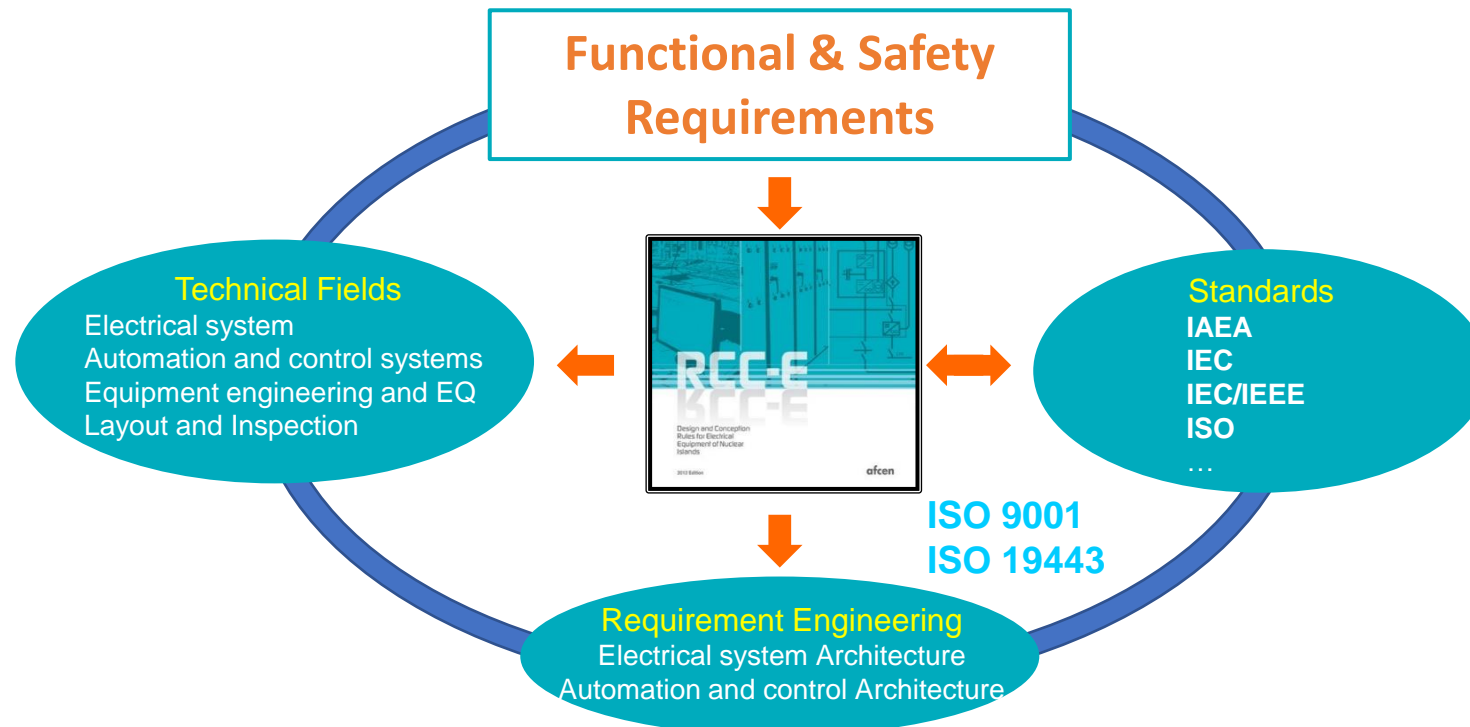
- Produce **up-to-date codes** offering accurate and practical rules for the design, construction and in-service inspection of components for use in industrial or experimental nuclear facilities (**RCC codes**),
- Ensure certified and readily-available **training programs** enabling code users to achieve a high level of expertise, knowledge and practical skills in using AFCEN codes.
- **AFCEN** comprises (2021) 67 institutional members, representing more than **880 experts** who contribute to the development and continuous improvement of AFCEN codes at the international level.

AFCEN Codes are a set of rules:

- Covering a wide range of technical fields: **mechanical engineering, electricity and I&C systems, nuclear fuel, civil engineering works and fire protection systems,**
- **Improved for the last 40 years**, particularly by using feedback that has been acquired from building and operating over 130 nuclear reactors around the world,
- **Generic**, not specific to a particular project

RCC-E overview

The RCC-E code provides a series of rules applicable to the **electrical and I&C systems and equipment** in order to guarantee safety of a PWR plant or other facilities, including EPR2 and SMR.



Covering

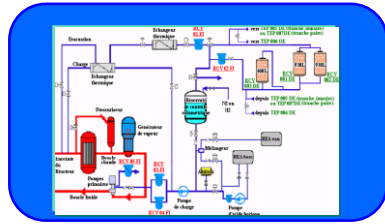
- ❖ Design and Construction of facilities,
- ❖ Design and Manufacturing of equipment (including spare parts and repairs),
- ❖ Equipment Qualification,
- ❖ On site Installation, Inspection and maintenance.

OUT of SCOPE {

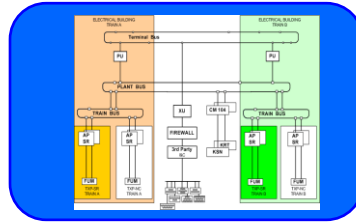
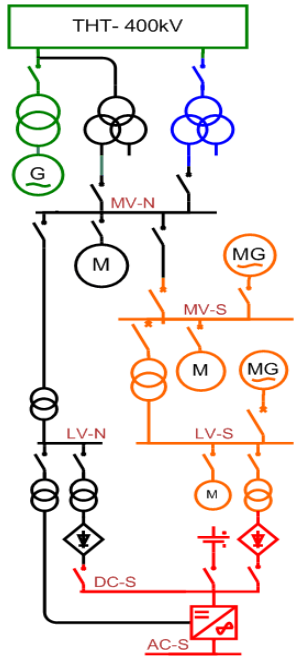
- telecom networks,
- non-safety-classified lighting networks,
- site security and surveillance facilities, site access control.

What are RCC-E aims ?

1) Ensure safety in the Facility and Equipment Design, Construction, Manufacturing and on site Installation and Inspection



2) Provide a reliable source of power with safety requirements => Electrical system



3) Monitor, inform, perform automatic actions => Automation and control systems, including cybersecurity prospects.



4) Ensure the independence required by the installation of equipment and systems
=> Layout of electrical and I&C systems



5) Provide reliable and qualified equipment in degraded environmental conditions => Equipment engineering and EQ



Based on functional and safety requirements, RCC-E ensures that the systems and components fulfil the required functions during the requested operating lifetime.

Equipment Qualification : what for ?

Electrical Equipment Qualification Process



Scope (IAEA Safety Guide on Equipment Qualification – SSG 69)

- Items important to safety
- Electrical, instrumentation and controls including smart devices, electromechanical, **active mechanical equipment** and interfaces associated with this equipment (e.g. seals, gaskets, connections, mounting structures and their anchoring)

Objective (RCC-E, IEC/IEEE 60780-323, *)

- The qualification is a declaration stating that an equipment **complies with all requirements of a standard or technical specification**, acknowledging **its ability to provide the required service under all the environmental conditions to which it might be subjected**.
- Equipment Qualification procedure aims to provide the **documented demonstration** that the equipment is fit to perform its safety functions(s) under the specified conditions.

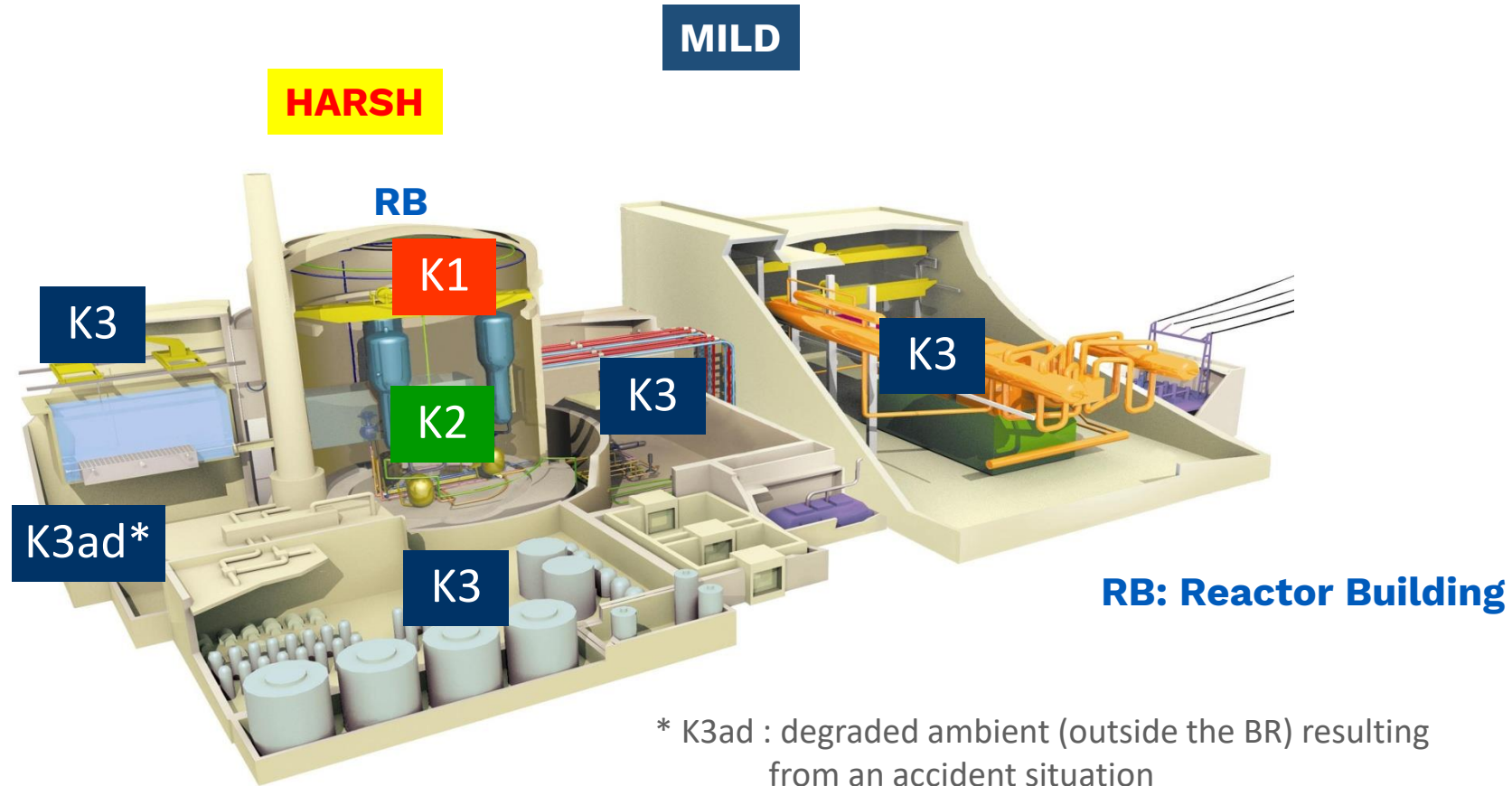
Qualification Process

The Equipment Qualification process considers three phases:

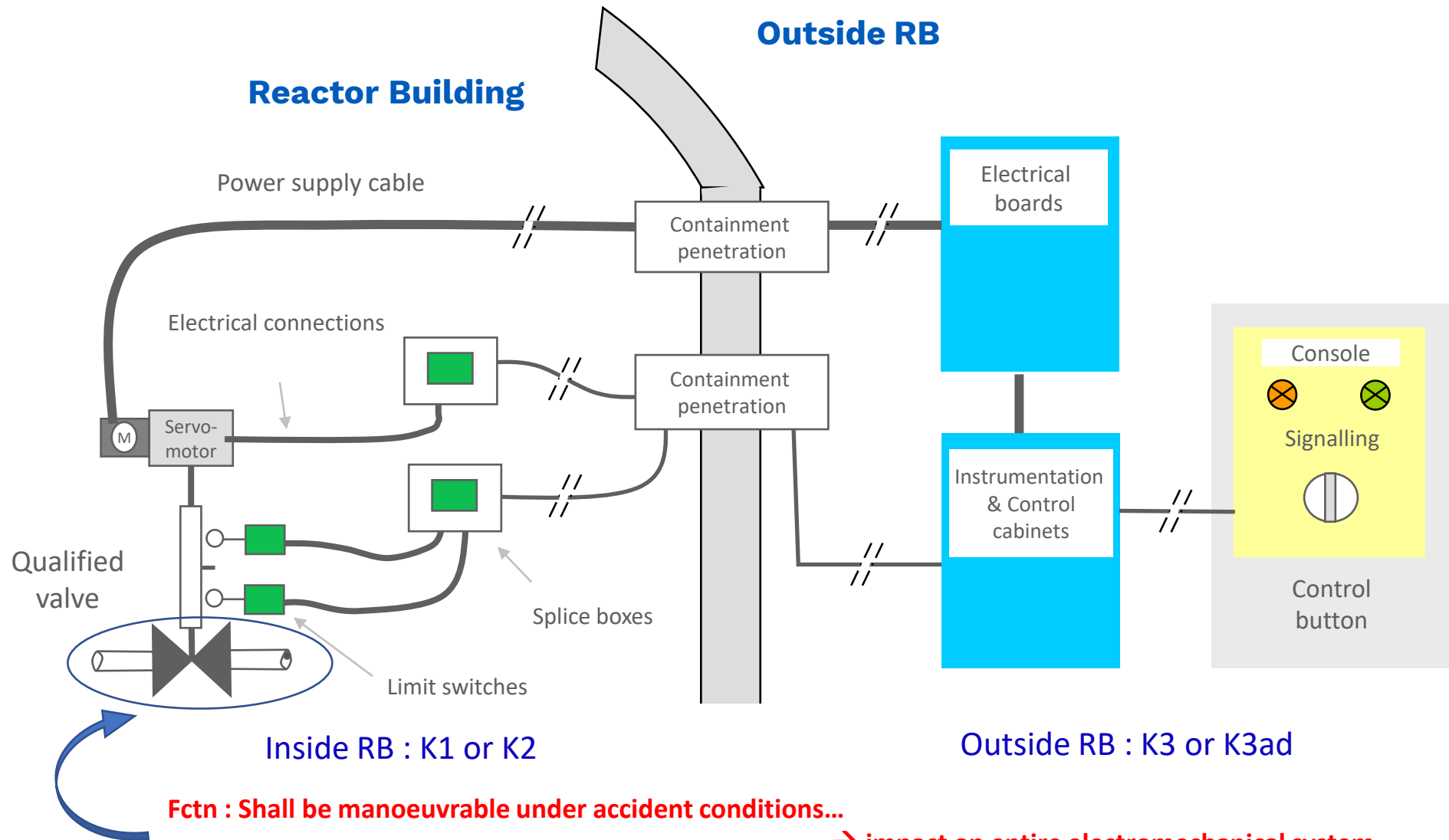
- Establishment of appropriate design inputs (**safety functions , environmental conditions, design, materials, interfaces, etc.**);
- Establishment of equipment qualification demonstration;
- Preservation of the status of qualified equipment.

Design, construction, test, inspection and maintenance measures ensure that this qualification remains valid for as long as necessary.

RCC-E Qualification quick illustration



RCC-E Qualification quick illustration



RCC-E Qualification methods

3 methods are used :

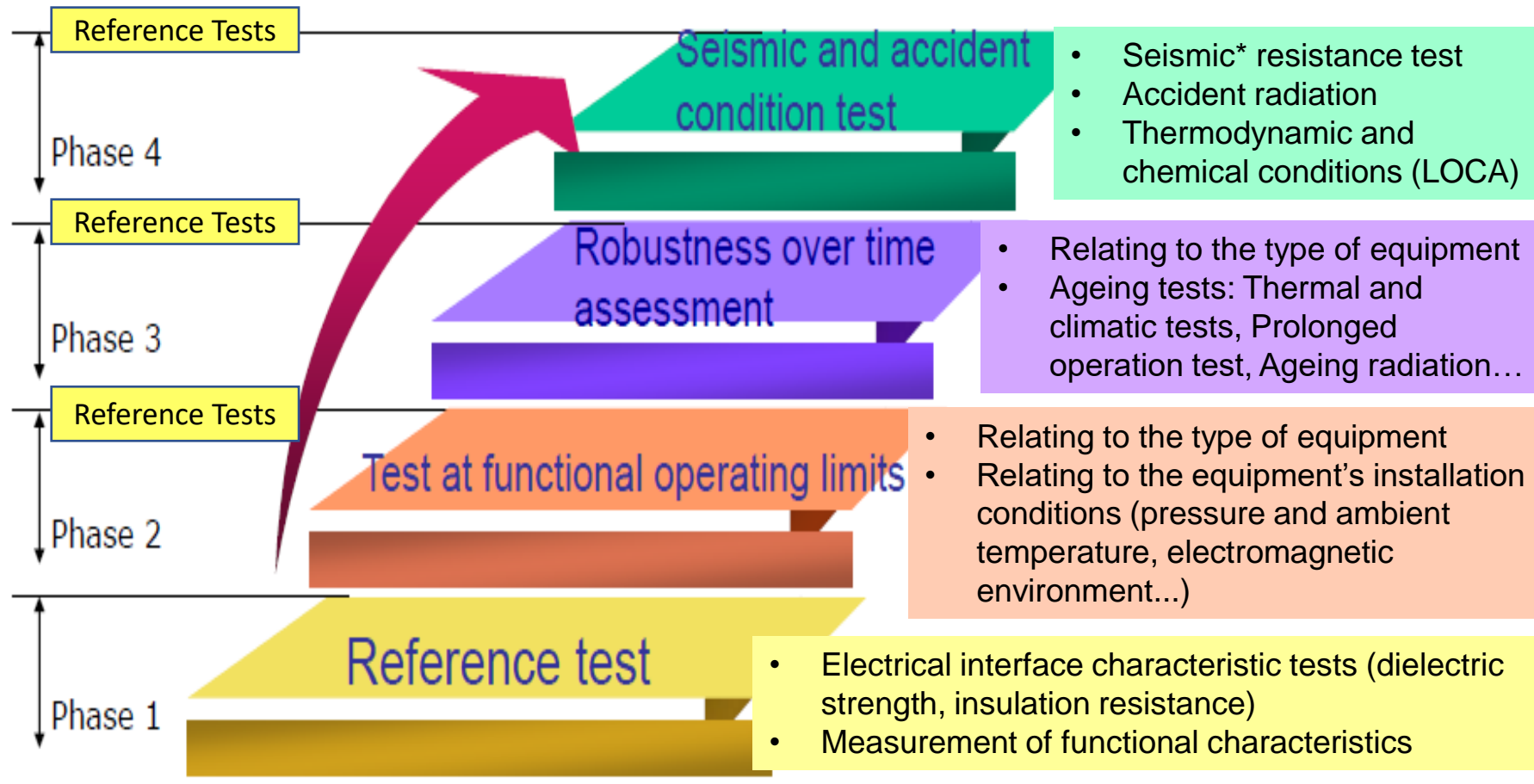
- Qualification by **testing**
- Qualification by **analysis or analogy**
- The **combined method**, which combines the two previous methods

3 steps are systematically involved :

- Defining the **strategy**
- Specifying the relevant **tests** based on the qualification strategy and requirements
- Drafting the **Qualification Summary Report** in order to
 - identify the concerned equipment and scope of validity, including qualified life assumption
 - summarise the obtained results

RCC-E Qualification : practical aspects

When testing is required the specification defines 4 major steps :



- Tests ought to be carried out using a **representative configuration**.
- **Reference Tests** : their repetition during the sequence (at least at the end of each phase) allows to detect a malfunction of the equipment which may occur during previous tests

RCC-E Qualification of Smart Devices

The industry has been providing over the years more and more "intelligent" devices in nuclear safety systems, moving away from the traditional analog devices.

These devices contain two separate fields requiring proof of ability to perform their specified safety function :

- **Hardware** (previous method is mandatory)
- **Software**

They **could take advantage of positive industrial operational experience**, but often the software development lifecycle **does not provide** the proofs required for the nuclear I&C standards (not developed according to IEC 61513, IEC 62138 or IEC 60880).

→ **There is a need for an adequate definition and qualification method :**

- IEC 62671 (SC45A) introduces *Digital Devices of Limited Functionality* (DDLDF) and a specific qualification process,
- IEC 61508 concerns functional safety of electrical/electronic/programmable electronic safety-related Systems (safety in a general meaning, not specifically nuclear).

RCC-E Qualification of Smart Devices

Qualification following IEC 62138, IEC 60880 is possible but at what a cost...!

RCC-E provides 2 paths :

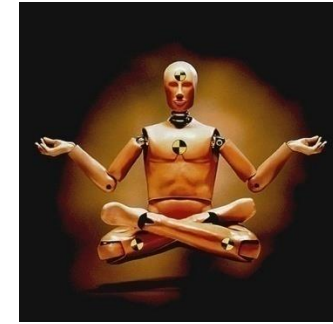
- General case, applicable to all such DDLFs → IEC 62671
- One preferred qualification method for devices which have been SIL (Safety Integrity Level) certified according to IEC 61508 (accelerated process if assumptions OK) :
 - ✓ Graded and flexible approach with complementary nuclear requirements
 - ✓ Transfer of certificate, documentation accessible in audit
 - ✓ Short qualifying period

The output of this process leads to an Evaluation and Application Report (EAR) attached to the qualification documentation.

Qualification preservation

RCC-E Qualification preservation

Performing all the previous steps demonstrates the equipment's ability to comply with the specified requirements.



Qualification during assembly and during the intended period of operation needs to be challenged by:

- preserving the qualification during manufacture,
- preserving the qualification during operation, by applying operating procedures (requirements and recommendations identified during the qualification process) and monitoring the equipment in service.



A failure to meet any requirement **shall** immediately **challenge** the equipment's qualification **status**.

This shall require Revalidation of the qualification status via the « re-assessment qualification process »

RCC-E Qualification re-assessment

Qualification re-assessment may arise due to non-compliance with recommendations, change of environment, operating beyond the planned period of operation (LTO), etc.

This shall induce performing a qualification extension programme before the equipment's service life exceeds the qualified life (or qualified limit conditions).

It is necessary to :

- Define the sequence of tests for assessing specific behaviour over time.
- Analyze the available qualification data (initial qualification, plant site effective loading and service monitored conditions...)
- Repeat the qualification process based on the new data

This leads to defining a new qualified life of each equipment (sometimes shorter than initial one due to change of environment), and sometimes to changing the equipment in order to ensure safety during the defined period of operation.

The methods included RCC-E are compliant with IEC/IEEE 60780-323.

Any questions ?

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