THE EUR ASSOCIATION – REVISION F OF THE EUR DOCUMENT AND ONGOING WORK ON SMR REQUIREMENTS

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Abstract

Since 1991, the European Utility Requirements (EUR) Association has been developing and promoting harmonized technical specifications for the new mid- and large-size LWR designs to be proposed by the vendors in Europe. In 2024, it is composed of 13 companies involved in new nuclear projects or in electricity generation from nuclear power in Europe. One objective of the EUR Association is to keep strong interactions with important stakeholders in the nuclear industry and regulation in Europe and worldwide, mainly: IAEA, WENRA, ENISS, WNA/CORDEL, European Commission (EC).
The EUR Association issues and, from time-to-time, modifies and updates a report entitled "EUR Document". It consists of a comprehensive set of requirements covering the whole Nuclear Power Plant (NPP). It encompasses all aspects (safety, performance, competitiveness) and all parts of a NPP (Nuclear Island and Conventional Island). The EUR Document can be used by the utilities (guide for design assessment, technical reference for call for bids) and by the vendors, as a technical guide.

The paper describes the main results obtained during the last years in the three following fields:

1. The last applicable revision, Revision E, of the EUR Document was issued in December 2016. It includes: Revised safety requirements taking into account the most recent European and international safety standards issued by WENRA and IAEA; The lessons learned from the Fukushima accident; and the most recent international standards, for example for I&C. The Revision E of the EUR Document has been benchmarked by the EC against recent safety standards.
2. The assessment of new designs. The Russian AEP's VVER TOI and Chinese CGN's EU HPR1000 designs have been assessed recently. One new design assessment is in progress (Korean KHNP's APR1000 namely). The presentation briefly recalls the EUR design assessment objectives and process and the progress of the different assessment projects.
3. The evolution of the EUR document towards integration of Small Modular Light Water Reactors (SMLWR). The paper presents the dedicated report issued by the EUR Association about high level requirements for SMLWR design.

1. INTRODUCTION

The development, the design, and the licensing of the existing Generation II Light Water Reactor (LWR) plants in Europe had been performed on a national basis with little interaction between countries. To overcome this weakness, in 1991 a group of five major European electricity producers formed the European Utility Requirements (EUR) Organization to develop and, from time-to-time update, a specification document for new LWR design [1] (called the "EUR Document" in this paper). In April 2021, the "EUR Association" was created as a legal entity (according to the French "1901" Law). The EUR Association nowadays gathers fourteen utilities which represent major continental European electricity producers operating a nuclear fleet of more than a hundred LWRs. Many of them are building or planning to build new reactors.
The focus of the EUR Association is the development of common specifications for new Generation III (GEN III) designs to be proposed by vendors in Europe and their promotion at the international level. The European utilities involved in the EUR Association aim at harmonizing and stabilizing the conditions in which the LWR Nuclear Power Plants (NPPs) to be built in Europe will be designed, built, commissioned, operated, maintained and decommissioned.
The harmonization of the requirements is sought after in the following fields:

- safety approaches, targets, and assessment methods,
- design conditions, design objectives and criteria for the main systems and equipment,
- equipment specifications and standards,

- information required for the assessment of safety, reliability, and cost, and some of the corresponding criteria,
  It allows the development of standard designs that can be built and licensed in several European countries with limited variations, depending on the local regulations and site characteristics.

2. THE EUR DOCUMENT

a. Overview of the EUR Document

As a general objective, the EUR Association promotes the development of NPPs providing robust behaviour and sufficient autonomy with respect to operator actions, as well as for water and power supplies. The EUR Document requires the NPP to be designed so as to have a low environmental impact on its surrounding environment and on the population by minimizing radioactive and chemical releases in all normal and accident conditions.

The EUR Document is not a regulatory document; it is endorsed by the major European electricity producers and is based on the most recent internationally recognized standards. Therefore, it is considered as the reference technical document for developing new NPPs and as guidance for defining user technical requirements and criteria of new GEN III projects. It has been recognized as one of the resource documents for the IAEA Reactor Technology Assessment process [2] and it has already been used as a technical basis for bidding purposes for new build projects in several countries in Europe (e.g., Hungary, Czech Republic) but also outside Europe (e.g., Kingdom of Saudi Arabia).

The EUR Document provides a comprehensive set of requirements for GEN III NPPs written by the utilities themselves, i.e., potential investors in the new designs proposed by the vendors. The requirements are grounded in the international design and operation experience which has been accumulated for more than four decades. The EUR Document covers the entire plant up to the grid interface. It is therefore the basis for an integrated plant design (i.e., Nuclear Island and Power Generation Plant). The EUR Document emphasizes those areas which are most important for the optimization of the design with respect to safety, performance, constructability, and economics.

The EUR Document is technology-neutral and does not favor any specific design. It applies to both Pressurized LWR and Boiling LWR. Only mid- and large size LWR plants are dealt with. Works to include requirements for Small Modular Light Water Reactors (SMLWRs) are in progress.

b. Structure of the EUR Document

The Volume 1 “Main policies and objectives” includes fiver chapters: Chapter 1.1 “Introduction to EUR” presenting the organization’s objectives; Chapter 1.2 “EUR policies” presenting the key policies driving the EUR requirements; Chapter 1.3 “EUR synopsis” providing an overview of the structure of the Document itself; Chapter 1.4 “EUR Key Issues” giving principal requirements selected by the EUR Organization to be met by a LWR in Europe; and Chapter 1.5 “EUR Key Positions on SMLWR” that are to be considered by a SMLWR design to be built in Europe.

The Volume 2 “Generic and Nuclear Island requirements” contains all the generic requirements and preferences of the EUR utilities for the Nuclear Island, and common requirements for Nuclear Island and Power Generation Plant. This volume represents about 4500 requirements. The EUR policy is to have a core of strong generic requirements expressed as objectives or functions as far as possible. Several of these requirements are kept open, i.e., they provide only a design methodology and objectives that can be implemented in several ways by the plant designer. The Volume 2 is structured into 20 Chapters, as follows:

EUR Volume 2: Generic and Nuclear Islands Requirements	
Chapter 2.1	Safety requirements
Chapter 2.2	Performance requirements
Chapter 2.3	Grid requirements
Chapter 2.4	Design Basis
Chapter 2.5	Codes and standards
Chapter 2.6	Material – related requirements
Chapter 2.7	Functional requirements: components
Chapter 2.8	Functional requirements: systems & processes
Chapter 2.9	Containment system
Chapter 2.10	Instrumentation &Control and Human – machine interface
Chapter 2.11	Layout
Chapter 2.12	Design process and documentation
Chapter 2.13	Constructability & commissioning
Chapter 2.14	Operation, maintenance and procedures
Chapter 2.15	Quality assurance
Chapter 2.16	Decommissioning
Chapter 2.17	PSA methodology
Chapter 2.18	Performance assessment methodology
Chapter 2.19	Cost assessment information requirements
Chapter 2.20	Environmental impact

The Volume 3 "Application of EUR to specific designs" consists of several subsets, each one being dedicated to a specific design that is of interest to the participating EUR Members and that has been assessed by the EUR Association against the EUR requirements. Each subset contains a description of a standard Nuclear Island, a summary of the analysis of compliance vs. the requirements of the Volume 2 and, where needed, design dependent requirements and preferences of the EUR Association's Members.
The Volume 4 "Specific Power Generation Plant requirements" contains about 1000 generic requirements related to the Power Generation Plant (Conventional Island).

3. EUR KEY POSITIONS ON SMLWR

It has been agreed by the EUR Members to promote and communicate the common EUR views through harmonized requirements on acute and up to date subjects. Among various topics, the emerging concept of Small Modular Reactors (SMRs) was considered as one of the major topics of interest.
Considering the EUR Members' knowledge based on Light Water Reactor (LWR) technology and the higher level of technical readiness of some models of Small Modular Light Water Reactors (SMLWR), the EUR Association has developed "EUR Key Positions" that are currently focused on SMLWR and limited to the case of water-cooled and land based SMR.
The EUR Key Positions are to be considered by a SMLWR design to be built in Europe, taking account of the specific features of SMLWR such as for example, integrated reactor vessel, passive safety systems and, for some of them, a multi-module unit configuration. They are intended to be a support for interacting with stakeholders such as IAEA, regulators (WENRA, SMR Regulators' Forum), European Commission, non-EUR utilities and vendors. The EUR Key Positions are formulated in terms of high-level requirements structured by Topics and Technical Items and are presented in the Chapter 5 of the Volume 1 of the EUR Document (see APPENDIX).

4. EUR DOCUMENT REVISION F

EUR Association Members have considered ways of improving the EUR Document Revision E, so that its future update would reflect most recent identified evolutions and perspectives of GEN III reactors. For this purpose, firstly, a process for partial update of EUR Document Revision E has been defined for taking into account feedback from EUR assessments, and various outcomes, and secondly the framework and scope of a potential future Revision F of the EUR Document was prepared in 2021. Revision F would integrate recent international standards and detailed requirements for SMR, with a special focus on the EUR Key Positions on SMLWR.

After preparation in 2021, the actual work on the EUR Document Revision F was launched in mid-2022. The organization is based on several working groups composed by specialists from different utilities. A Chapter Leader is appointed for updating each of the EUR Revision F Volume 2 chapters (See Fig. 2. of this paper) and one for the whole Volume 4. The first step was to define the scope for updating the EUR Document Revision E to F; five major topics were defined:

- Topic 1: Requirements applicable to the design of SMR on the basis of an internal report, "EUR Position Paper on SMLWR". This report addresses more extensively than the EUR Key Positions on SMLWR, the technical topics listed in Appendix;
- Topic 2: Up-to-date international recommendations, standards, and guidance such as IAEA safety guides [3] and [4], WENRA reports [5] to [7] and IEC standards [8];
- Topic 3: Introduction of new generic technical items for LLWR and SMLWR designs, such as Cybersecurity, or types of fuel.
- Topic 4: Feedback from EUR design assessments: "HOLD" labels assigned to requirements. The HOLD-label is used to mark that feedback is provided for a specific requirement. The feedback is assigned to one of following category: HOLD(A) are the most serious technical findings having direct impact on the assessment such as e.g., the requirement is seemingly unreasonable or practically impossible to fulfil or HOLD(B) are technical findings but not directly impacting the assessment such as e.g., contradiction with other requirement, poor formulation, etc. HOLD(C) are formal findings such as typing errors, suggestions to restructure or split composite requirements. Throughout the Revision E project, Chapter Leaders and Project Manager wrote a background report that presents the main changes in Revision E and proposes changes/updates for the EUR Document Rev. F.
- Topic 5: Consideration of a set of "technological-neutral" overarching High-Level Requirements (HLR) for a new reactor design (LLWR, SMLWR…). They will extend the scope of the EUR KEY POSITION on SMLWR (see Chapter IV of this paper). These HLR must be considered for designing SMLWR to be built in Europe, complementarily with the Volume 2 of the EUR Document. A new dedicated Chapter in the Volume 1 will present a clear link with EUR general approach/safety philosophy as in Chapter 1.2 and the HLR covering the detailed requirements for LWR GENIII/advanced reactors presented in the Volumes 2 and 4. . The number of HLR should be limited to allow overview by any external User. One of the important initial steps was to define an approach and the criteria for HLR (e.g., technology-neutral, not solution-oriented).

5. EUR ASSESSMENTS OF LWR DESIGNS

a. EUR Design Assessment Process

Several LWR designs have been already assessed from late 90' against EUR requirements after application to EUR Association by worldwide Vendors. A nuclear project can be considered as an acceptable candidate to the EUR design assessment when it meets the following conditions:

- It is a LWR plant that meets the EUR objectives in safety, performance and costs;
- Its Vendor intends to be present on the European market and has found at least two "sponsors" and 2 "supporters" amongst the EUR Association Members;
- Its level of development is sufficient to allow a detailed assessment of compliance vs. Volume 2 of the EUR Document;
- The project documentation is accessible to the assessment performers (language, conditions of use, specific agreement needed, etc.);
- Sufficient resource is available on the Vendor side as well as on the EUR Association side to develop the corresponding subset of Volume 3 (plant description, detailed analysis of compliance, syntheses, specific requirements, reviews, etc.).

Taking advantage of the numerous design assessments carried out since its creation, the EUR design assessment process has been continuously improved by improving the efficiency of the next design assessments and in particular to optimize their duration.

The different steps of the preparation phase and of the assessment phase itself have been explicitly described in an EUR report titled "Generic Assessment Principles". This document defines the standardized processes to initiate, plan and operate EUR design assessment projects. In addition, a "Standard Project Manual" has been developed in order to provide both the team of utilities and the Vendor with a detailed basis for deriving their specific assessment project manual. The preliminary work which has to be performed by the vendor before launching the assessment by the EUR utilities has been clarified. It includes the "EUR pre-assessment" phase to be carried out by the Vendors against the EUR "Key Issues" listed in the Chapter 1.4 of EUR Document, to be pre-assessed to get confidence that their design will be generally in line with the EUR Document.

b. Recent EUR Assessments of LWR designs.

Between 2015 and 2017, EU-APR designed by South Korean KHNP was assessed against EUR Document Revision D. This is the European version of APR1400, with enhanced level of safety.

Between 2016 and 2019, VVER TOI designed by Russian AEP (AtomEnergoProekt) was assessed against EUR Document Revision D. This is a GEN III evolutionary design, resulting from optimization and improvements of the previous AES-2006 design.
Between 2018 and 2020, EU-HPR1000, which is European version of the Chinese CGN's HPR1000, was assessed using EUR Document Revision E for the first time.
Between 2021 and 2023, APR1000 which is a European version of the KHNP's APR1400 was assessed against Revision E of the EUR Document.

6. INTERACTION WITH EXTERNAL STAKEHOLDERS

The EUR Association intends to further develop its existing interactions with international stakeholders in nuclear industry, like IAEA (EUR has an observer chair in IAEA/ NUSSC and WASSC), WENRA (in cooperation with ENISS), EC, WNA/CORDEL and SMR Regulators' Forum. The EUR Association wants also to promote its products (mainly the EUR Document and the design assessments) through its website [1], organization of training sessions on the EUR Document, participation in international conferences, workshops and seminars.
The EUR Association intends to widen its representation by enrolling new European utilities as "Full" or "Associated" EUR Members, and to develop interactions with utilities worldwide by promoting the "Observer" status which allows Non-European Utilities to join the EUR Association. The Japanese utility TEPCO and the Power Generation Division of South Korean KHNP are Observer EUR Members.

7. CONCLUSIONS

The paper summarizes the main achievements obtained by the EUR Association over the last years. The development of the safest and the most competitive designs remain the highest priority for new nuclear build projects all over the world and in Europe in particular. In order to achieve this goal, the EUR Association will keep on developing harmonized and standardized Utility requirements, which are based on a solid design, licensing and operating experience throughout Europe. The main goal of the EUR Document Revision F is to be applicable to both LLWR and SMLWR.

8. NOMENCLATURE

DiD	Defense-in-Depth
EUR	European Utility Requirements
GENIII	Generation III
HLR	High Level Requirement
(L)LWR	(Large) Light Water Reactor
NPP	Nuclear Power Plant
SM (LW) R	Small Modular (Light Water) Reactor

9. REFERENCES

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[4] *Design of Fuel Handling and Storage Systems for Nuclear Power Plants, No. SSG-63,* IAEA 2020.
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[6] *Guidance Document Issue TU: External Hazards Head Document, Guidance on External Flooding, Guidance on Extreme Weather Conditions, Guidance on Seismic Events,* WENRA 2020.
[7] *Report, Regulatory Aspects of Passive Systems,* WENRA 2018.

[8] *Instrumentation, control and electrical power systems important to safety – Categorization of functions and classification of systems,* IEC 61226 Nuclear Power Plants.

10. LIST OF TOPIC AND TECHNICAL ITEMS FOR EUR KEY POSITIONS ON SMLWR

Topic A: Safety
- Probabilistic design targets
- Emergency Planning Zone
- Defense-in–Depth
- Complex sequences (Design Extension Conditions)
- Autonomy objectives
- External hazards
- Safety of multi-module units

Topic B: Systems & Components
- Innovative components
- Passive systems
- Containment and HVAC systems
- Main Control Room and I&C systems
- Turbine and Conventional Island

Topic C: Performance
- Availability factor targets
- Flexibility
- Fuel cycle management
- Boron-free concept
- Spent fuel storage and handling

Topic D: Operation & Maintenance
- Maintainability
- Staffing in multi-module units
- Remote Shutdown Panel and Emergency Control Room
- Emergency response organization
- Decommissioning

Topic E: Cost and Constructability
- Construction methods
- Standardization
- Staggered deployment
- Load following and cogenerating capabilities