European Utility Requirements for LWR nuclear power plants

Status and near-term works on the EUR document, possible use by third parties

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Contents

- the EUR organisation, its objectives
- the generic requirements
- assessment of the reactor designs
- the roadmap
- possible use by third parties
EUR: a mature cooperative organisation of European utilities

- working together since 1992
- committed to keep the nuclear option open
- sharing specification and development works for Gen 3 LWR plants
- today involving most of the major European electricity producers.
- operating a very large nuclear fleet: more than 130 LWRs + others
- in competition with each other
**EUR: a hub to harmonise European utilities views & requirements**

- **a utility network**
  - to share experience in plant specification, design evaluation, licensing …
  - to build common specifications for the European Gen 3 LWR NPPs

- **a common bridge with the external stakeholders**
  - the vendors
  - the EUR utility counterparts outside Europe: EPRI, Asian utilities,…
  - the regulators: safety, HV grid, …
  - the international organisations: IAEA, OECD, EU, …

- **making Gen 3 a reality in Europe**
A single product: the EUR document

- a document written by investors & operators
  - Not a regulatory document
  - Wide experience basis (> 6 vendors & 16 operators in Europe)
- open
  - Design objectives and functional requirements
  - Assessment of the level of compliance of the designs of interest for the EUR utilities
  - Modular structure, versatile, easy to adapt
- neutral
  - Does not favour any specific design
  - Does not forbid, except where there is a bad operation experience or an unacceptable industrial risk
- Design guidelines to develop the future European standardised LWR plants
- A possible base to call for bids
Thorough benchmarking

- Tests vs. the advanced LWR designs proposed by the vendors for the European market.
  - Detailed assessment of compliance of Gen 3 LWR projects in the frame of the EUR volume 3.
  - Several successful calls for bids based on EUR since 2003
- Comparison with the other specification documents, especially in the safety area
  - EPRI-URD
  - Key US safety regulations
  - IAEA Safety Standards
  - WENRA "reference levels" (operating plants, next Gen 3)
The EUR document contents and status

- **Volume 1** presents the main utility objectives and summaries the main requirements.
- **Volume 2** is a set of generic nuclear island requirements. The contents cover most of what a Plant Owner has to specify for the assessment, licensing, design, supply, construction, tests and operation of a future LWR power plant.
- **Volume 3** includes evaluations of the selected LWR designs that are felt feasible for the European market. There is a subset of volume 3 per project, produced with contribution of the corresponding vendor.
- **Volume 4** is a set of generic requirements for the power generation plant organised by chapters that deal with the specific systems.
EUR: the generic requirements
Expected designs

- **Advanced LWRs (Gen 3) only**
  - Positive experience in design, manufacturing, construction, licensing and operation (1960's to today)
  - High operational performance
  - Acceptable technological risk for the investors and the bankers
  - Safety design objectives in line with the most recent licensing operations in Europe

- **Large units: 1000 to 2000 MWe**
  - Scarce sites
  - Difficult (and quite long) siting procedures

- **Available designs in Europe**
  - By European vendors
  - By any other vendor that plans to be present in Europe
The main drivers considered in the EUR document

- Nuclear safety
- Investment protection
- Public acceptance
- Operational performance
- Capital cost of new builds
- Standardisation of the designs
Safety

- Public and staff health, environment conservation
- The risk that the public, the staff or the environment be submitted to intolerable radiological conditions must be sufficiently low
- Probabilistic risk assessment
- Deterministic approach to be implemented first (design basis)
  - Defence in depth: several barriers and redundant mitigation systems must be provided
  - Safety classification,
  - ...
- Design Extension approach (Beyond Design Basis)
- Physical protection (external hazards and attacks)
Financial risk: investment in nuclear plants is atypical with reference to other electricity generation means. The high capital burden deserves specific protection.

The risk that operation of the power station could be interrupted permanently or for a long period must be sufficiently low. This involves limiting the risk of accidents that could lead to major production losses, nuclear (core damage) as well as non-nuclear.

On a given system/component, the level of protection sought for investment protection may be more stringent than the one derived from nuclear safety.

Design lifetime of the plant

Possible reparation or replacement of all the critical components
The EUR volume 3: evaluation of the designs
First evaluation started in 1995 as soon as rev B of EUR volume 2 was frozen.

The "historical" vendors already present in Europe first to come:
- NPI (Framatome + Siemens), ABB Atom, Westinghouse
- Then GE and the Russian vendors

Other vendors willing to be present in Europe candidate to the next evaluations.

A complete range of Gen 3 LWR projects:
- PWRs and BWRs
- "evolutionary" and passive safety features
- No Gen 2, no Gen 4
EUR volume 3: analyses of compliance of selected LWRs vs. the EUR generic requirements

- analyses at detail level
  - each of the 5000 requirements (shall, should, may) of the EUR volumes 1 & 2 is analysed by EUR utilities' engineers from information supplied by the vendors.
  - standard scale of compliance for all the projects
  - rationales & references
  - cross-checking between the different assessments
  - several man-years for each project

- the detailed analyses are not published
- only the main deviations are highlighted in the published part as well as the main "compliance with objectives".
Typical table of contents of a subset of volume 3

- Chapter 3X.0 introduction
- Chapter 3X.1 XYZ plant description
- Chapter 3X.2 highlights of the compliance analysis
  - 3X.2 1 Introduction
  - 3X.2 2 Assessment process
  - 3X.2 3 Highlights of the analysis of compliance
    - general observations
    - main compliances with objective (CWO)
    - non compliances (NOC)
    - main beyond requirement issues (BRE)
  - 3X.2 4 Synthesis reports by chapters
- Chapter 3X.3 specific requirements
**EUR volume 3 status**

- **BWR 90/90+**
  - 1400 MWe
  - Evolutionary BWR
  - Westinghouse

- **EPR**
  - 1600 MWe
  - 4-SG evolutionary PWR
  - Areva

- **EP 1000**
  - 1000 MWe
  - 3-SG PWR
  - Areva

- **SWR 1000**
  - 1000 MWe BWR
  - With passive safety features
  - Westinghouse

- **ABWR**
  - 1400 MWe
  - Evolutionary BWR
  - General Electric

- **AP 1000**
  - 1000 MWe
  - 4-SG PWR
  - With passive safety features
  - Westinghouse & Ansaldo

- **VVER AES-92**
  - 1000 MWe
  - 4-SG PWR
  - With passive safety features
  - AEP Moscow

- **Standard EPR (rev. B)**
  - 1600 MWe
  - 4-SG evolutionary PWR
  - Areva
Outcome of the EUR Gen 3 projects evaluations

- A cooperative work
  - the utilities and the vendors work together to come to common positions.
  - The level of detail of the assessment makes all the parties aware of the strong points as well as of the weak points

- A large investment for each project by the vendors and by the EUR utilities
  - several man\-year per project evaluation

- High value for both the vendor and the utilities
Outcome of the EUR Gen 3 projets evaluations

- A powerful tool to make the designs fit the utility requirements
  - common (strong) positions by the owners/operators
  - diverse interests → robustness of the analysis
  - shared costs allows several in-depth analyses be undertaken

- A powerful tool to promote the designs
  - a design that has a good record of compliance vs. the EUR can be promoted as a real Gen 3 project that meet the owner expectations.
  - certificates granted to the designers
The roadmap
EUR: a strong base for harmonisation & standardisation of the designs

- Continuous activity over more than 15 years has made the EUR organisation **one of the central actors** in the development of the Gen 3 LWRs in Europe and worldwide.

- In its current stage the EUR document is **fully operational**.

- Actually used as technical specification to call for bids.

- Actually used by the NPP vendors willing to be present in Europe, as a guide for designing their new products.

- A **living document** that follows up the progress of technology and the constraints coming from Europe integration.
the trends: the EUR volume 3

- the evaluations of compliance will follow on the projects developments and be updated when necessary
  - revision B of the EPR evaluation being published,
  - preliminary works on MHI's APWR,
  - other Gen 3 LWR projects to be considered

- short list of the Gen 3 projects that can be called for a bid
  - an industrial role given to the EUR organisation
  - a powerful tool to make the Gen 3 LWR designs fit the utility requirements and to promote the designs of interest for the utilities

- the corresponding EUR generic requirements might be adapted
the trends: the generic Gen 3 requirements

- Volumes 1, 2 & 4 initially designed as development guidelines
  - Still used for that purpose: EPP, EU-APWR, Atmea, …
  - Also used several times to build technical specifications for Gen 3 reactor bids worldwide in the last 3-5 years

- Will to keep the EUR document living and usable
  - volumes 1, 2 and 4 maintained and improved
  - various inputs to a next revision collected and preserved
  - limited resource available at the utilities: slow pace
The trends: participants to the EUR organisation

- 16 European utilities or utility groups actively participating
  - Western, central and eastern Europe utilities
- The EUR organisation keeps enlarging
  - EnergoAtom (Ukraine), CEZ (Czech Republic) have been welcomed into the EUR organisation
  - ENEL and Endesa have re-entered the organisation
  - MVM (Hungary) has been admitted as an associated member
- The other European electricity producers that consider nuclear generation can legitimately apply for participation
the trends: associated organisations

- Other organisation outside Europe have been associated to the works and have been authorised to use the EUR document for their own needs.

- Cooperation agreements: Electronuclear (Brazil), BINE (China), AECL (Canada)

- Agreements to authorise the use: Eskom (SAR), Belene (Bulgaria)
the trends: reinforced dialogue with the stakeholders other than the vendors and the utilities

- EUR focused on Gen 3 LWRs
- Dialogue with the other organisations involved in Gen 3 LWRs development and deployment
  - Within Europe: WENRA, EC through/with Foratom
  - At global level: EPRI, IAEA, OECD/NEA, MDEP, WNA, other regional utility groups, codes & standards, ...

→ inputs to a revision of the EUR document
→ influence on the documents developed by other organisations
→ harmonisation of the design requirements
Standardisation keeps the ultimate objective

- Common design rules pave the way to standardisation.
- The utility set their design targets:
  - operational performance, designs features, construction, ...
- The regulatory requirements should be harmonised at a sufficient level:
  - safety, HV transmission grid, ...
  - more generally all the regulations that can hinder design replication
  - down to specific approaches and practices … the devil is in the details …
- When the same rules apply in a wide area:
  - the market gets large enough
  - designers can develop standardised designs
Standardisation gives benefits to all parties

- The same design is usable by different utilities in different countries without specific re-development.
- Licensing, safety and engineering studies costs can be shared:
  - Between regulators
  - Between investors
- The licensing risk gets limited: the investors can borrow money at acceptable conditions, interests during construction (IDCs) keep under control.
Use of EUR by third parties
How other organisations can use EUR to formulate their own requirements?

● Several examples of use of the EUR document to prepare a call for bid
  ● By utilities participating to EUR
  ● By utilities that did not participate to the making of EUR

● Same principles
  ● Short list of projects taken from EUR volume 3
  ● Bid technical specifications taken from the EUR volumes 1, 2 & 4
  ● Legal and commercial specifications taken from other sources

● A proven approach
Example of the making of the TVO Bid Inquiry Specification for Finland 5
EUR organisation access policy

- Harmonisation of the design requirements worldwide has a high value
  - Wide harmonisation sought
  - A prerequisite to design standardisation and licensing stability
    - Standardised products usable in large areas
    - High potential benefits on investment and operation
- Open access policy to utilities that are potential users
  - Whole EUR document
  - Copyrights, specific conditions of use
- Restricted access to volume 3
  - The vendors have access to what deals with their own projects
  - A vendor can deny access to any external party
European Utility Requirements for LWR nuclear power plants

http://www.europeanutilityrequirements.org