EUR

HARMONISED REQUIREMENTS FOR
NEW NUCLEAR POWER PLANTS

The EUR Document

EUR
HARMONISED REQUIREMENTS FOR
NEW NUCLEAR POWER PLANTS

Objectives of the course

1/ The EUR Document: Purposes

2/ Content of the EUR Document

3/ EUR considerations on SMRs & Key positions

4/ The EUR Document Revision E

- Detailed content
- How to get it ?

1/ The EUR Document - Purposes

“European Utility Requirements for LWR Nuclear Power Plants”

- **The EUR Document presents a comprehensive statement of nuclear Utility expectations for new LWR designs (including SMR) to be proposed by the Vendors in Europe with respects to safety, performance, constructability, and economics.**

- **The EUR Document covers the entire plant up to the grid interface requirements. The requirements are grounded in proven technology from more than 50 years of commercial European and international LWR experience.**

- **The EUR Document has already been used as a technical basis for bidding purposes for new build projects in several countries in and outside Europe.**

- **The EUR Document is regularly updated and enriched in order to accommodate the evolution of the regulatory and industry background as well as to take into consideration the feedback of experience from design, licensing, construction, and operation of NPPs.**

1/ The EUR Document – Current Status

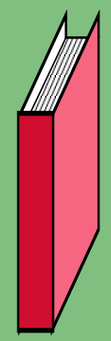
- **Revisions A published in 1994**
- **Revisions C and D was respectively published in April 2001 and October 2012**
- **Revision E was published in December 2016 in line with international standards issued after the Fukushima-Daiishi accident**
- **Revision E1 was issued in December 2020 for text improvements**
- **Revision E2 was issued in May 2021 with introduction of a dedicated Chapter dealing with SMR: "EUR Key Positions on SMLWR ".**

- **The success story is going on as the Revision F is being prepared and will address detailed requirements for Light Water SMR more extensively.**

2/ Content of the EUR Document (Rev.E)

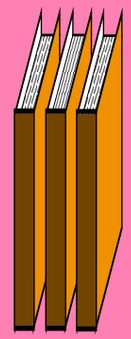
- **The EUR Document is composed of 4 Volumes**

Volume 1



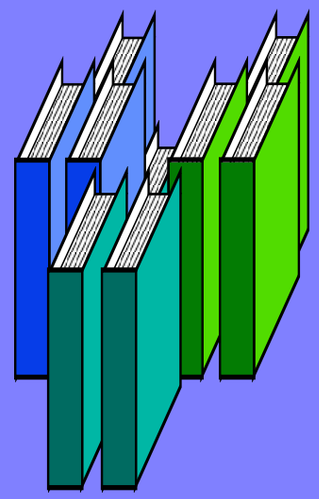
Main Objectives and Policies

Volume 2



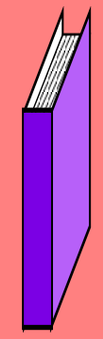
Generic and Nuclear Island requirements

Volume 3 subsets



Application of EUR to specific Gen3 LWRs designs

Volume 4

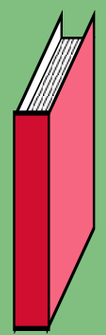


Specific Power Generation Plant requirements

2/ Content of the EUR Document (Rev.E)

Available on the public EUR website

Volume 1



Main Objectives and Policies

Chapter 1.1: “Introduction to EUR”

- General information about the EUR organisation

Chapter 1.2: “EUR policies”

- 5 Policies aiming at summarise the EUR Organisation policy to reach safety and competitiveness objectives for new designs

Chapter 1.3: “EUR synopsis”

- Presentation of the EUR document and user manual

Chapter 1.4: “EUR Key Issues”

- List of the 53 key issues to be used for design assessments versus EUR

Chapter 1.5: “EUR Key Positions on SMLWR”

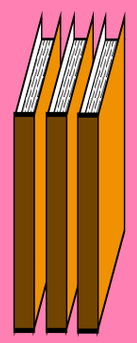
- High-Level Requirements to be considered for designing Small Modular Light Water Reactors (SMLWR) to be built in Europe, complementarily with the Volume 2 of the EUR Document .

Appendix A: Abbreviations and Acronyms

Appendix B: Definitions

2/ Content of the EUR Document (Rev.E)

Volume 2

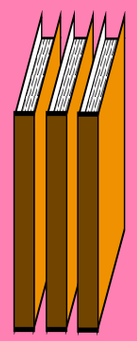


Generic and Nuclear Island requirements

- **Volume 2 is a set of Generic and Nuclear Island requirements. The scope covers 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.**
- **20 chapters**
- **~ 1500 pages**
- **~ 4500 requirements**
- **Basis for EUR Assessments of new Designs**

2/ Content of the EUR Document (Rev.E)

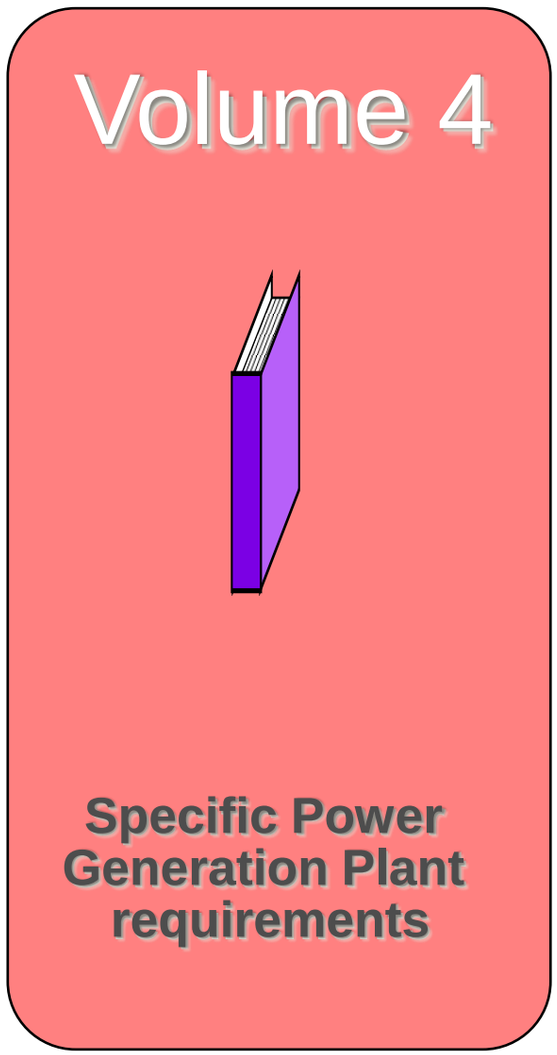
Volume 2



Generic and Nuclear Island requirements

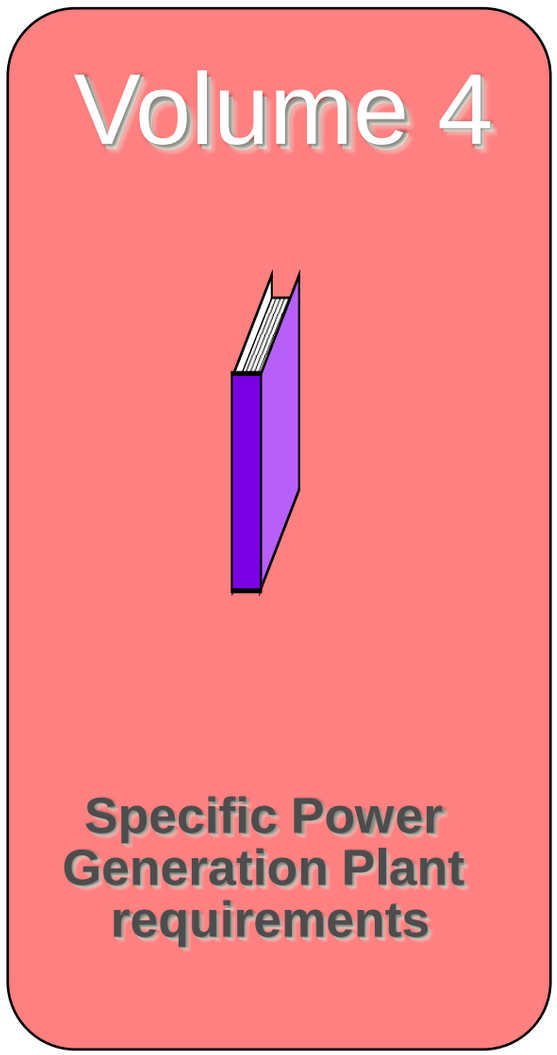
Volume 2: Generic and NI requirements	
Chap.	**item**
2.1	Safety
2.2	Performance
2.3	Grid
2.4	Design Basis
2.5	Codes & Standards
2.6	Materials
2.7	Components
2.8	Systems & Processes
2.9	Containment
2.10	I&C & HMI
2.11	Layout
2.12	Design Processes & Documentation
2.13	Constructability & Commissioning
2.14	Operation, Maintenance & Procedures
2.15	Quality Assurance
2.16	Decommissioning
2.17	PSA Methodology
2.18	Performance Assessment Methodology
2.19	Cost Assessment Information
2.20	Environmental Impact
About 4500 requirements	

2/ Content of the EUR Document (Rev.E)



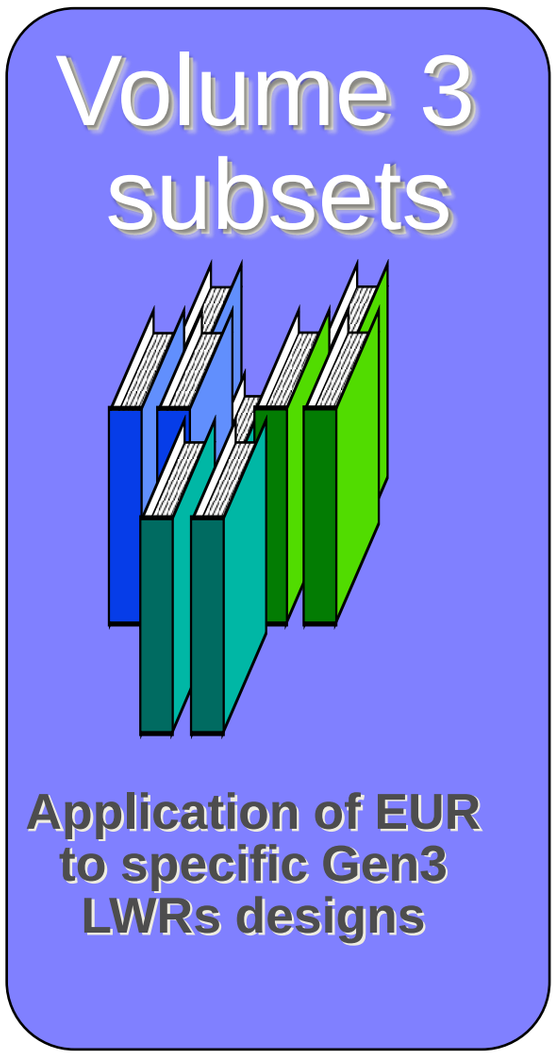
- **Volume 4 is a set of generic requirements for the Power Generation Plant (PGP) organised by chapters that deal with the specific systems.**
- **Turbine Island EUR requirements**
- **~ 300 pages**
- **~ 1000 requirements**

2/ Content of the EUR Document (Rev.E)



Volume 4: Specific PGP requirements	
Chap.	**item**
4.1	Introduction to the Volume 4
4.2	Main turbine generator systems
4.3	Steam, condensate and feed-water system
4.4	Electric Power systems
4.5	Circulating water systems
4.6	Auxiliary systems
About 1000 requirements	

2/ Content of the EUR Document (Rev.E)



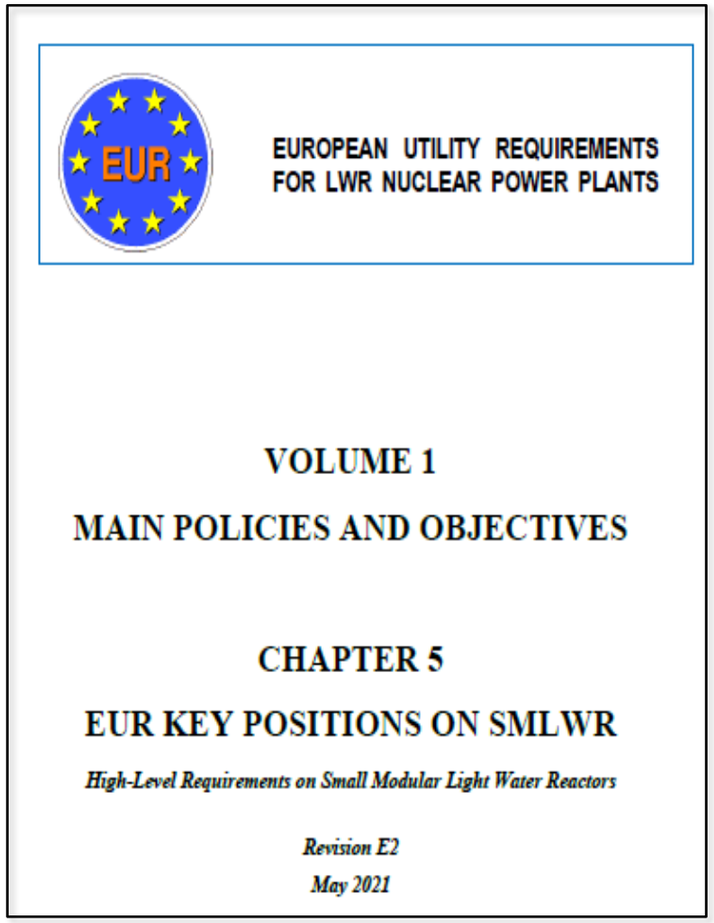
- **The Volume 3 "Application of EUR to specific designs" consists of several subsets, each one being dedicated to a specific design that has been assessed by the EUR Organization against the EUR requirements.**
- **No EUR requirement in Volume 3**
- **Contains the highlights of the EUR assessment**
- **Not a « public » document !**
- **Limited access to :**
  - **EUR members and assessed designer**
  - **Other recipient with the autorisation of the designer and the signature of a Non-Disclosure Agreement**

3/ EUR Considerations on SMR

- **In 2019, it has been agreed by the EUR members to promote and communicate the common EUR Organisation's views through harmonised requirements on the emerging concept of SMR.**
- **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 Organisation has developed two reports, focused on SMLWR and limited to the case of water-cooled and land-based SMR, for two audiences:**
  - **"EUR Position Paper on SMLWR", which is an EUR internal report intended to be used by EUR members as an input for a future revision of the EUR Document.**
  - **"EUR Key Positions on SMLWR" intended to support interactions with external stakeholders**

3/ EUR Key Positions on SMLWR - Overview

- The **EUR Key Positions** are publicly available in the Chapter 5 of the Volume 1 of the EUR Document Revision E2 to support interactions with external stakeholders.
- They should be considered for designing SMLWR to be built in Europe, complementarily with the detailed requirements for new LWR design expressed in the EUR Document Volume 2.
- The Key Positions are formulated as "**High-level Requirements**" structured by Technical Topics and Items.



EUROPEAN UTILITY REQUIREMENTS
FOR LWR NUCLEAR POWER PLANTS

VOLUME 1

MAIN POLICIES AND OBJECTIVES

CHAPTER 5

EUR KEY POSITIONS ON SMLWR

High-Level Requirements on Small Modular Light Water Reactors

Revision E2

May 2021

Topic A: Safety	Topic B: Systems and Components	Topic C: Performance	Topic D: Operation and Maintenance	Topic E: Cost and Constructability
KP 1 – Probabilistic Design Targets KP 2 – Emergency Planning Zone KP 3 – Defence-in-Depth* Approach KP 4 – Complex Sequences* (DEC) KP 5 – Autonomy Objectives KP 6 – External Hazards* KP 7 – Safety of multi-module Units*	KP 8 – Innovative Components KP 9 – Passive Systems KP 10 – Containment and HVAC Systems KP 11 – Main Control Room* and I&C Systems KP 12 – Turbine and Conventional Island	KP 13 – Availability Factor Targets KP 14 – Flexibility KP 15 – Fuel Cycle Management KP 16 – Boron-free Concept KP 17 – Spent Fuel Storage and Handling	KP 18 – Maintainability KP 19 – Staffing in multi-module Units* KP 20 – Remote Shutdown Panel* and Emergency Control Room* KP 21 – Emergency Response Organisation KP 22 – Decommissioning	KP 23 – Construction Methods KP 24 – Standardisation KP 25 – Staggered Deployment KP 26 – Load Following* and Cogenerating Capabilities

3/ EUR Key Positions on SMLWR - Example

KP n°	Topic	Technical item	Text of the EUR Key Position on SMLWR
KP 2	**Safety**	**Emergency Planning Zone**	**High-level requirements** A. The design shall support an EPZ much smaller than the EPZ for a nuclear site with large reactor. B. The evacuation zone should be as close as reasonably possible to the nuclear site boundary. C. To support the two previous requirements, the Designer* shall demonstrate reduced risk profile and source term. **Comments:** • *The Emergency Planning Zone (EPZ) is the geographic area in which implementation of operational and protective actions may be required during a nuclear emergency, in order to protect public health, safety, and environment.* • *Protective actions in the Emergency Planning Zone (EPZ) regarding public health, safety and environment are defined, and they are implemented according to the severity of the situation.* • *The results of the hazard assessment (e.g., potential consequences of several reactor modules failing simultaneously due to External Hazards*, see Key Position #7), the technology, including novel features, and the specific design criteria, as well as specific emergency preparedness policy factors may affect the methodology for EPZ assessment.*

4/ The EUR Document Revision E - Content

What is an EUR requirement ?

Each of the 5500 EUR Requirements is written as a:

« SHALL » requirement

Any design that does not fulfil these requirements will be deemed non-compliant

« SHOULD » requirement

Other solutions can be accepted, but the Plant Designer will have to demonstrate that they are equivalent or better

+

Additional comment

+

Applicability Identification (TAGGING)

4/ The EUR Document Revision E - Content

Example of EUR requirement :

2.4 1.2.2 External air temperatures and humidity conditions

A The Design Basis External Hazards* (DBEH) values of external air temperatures to be considered in the Standard Design shall be as follow:

- long-term base temperature: -29°C to +36°C (extreme temperature for periods > 7 days);
- short-term daily temperature: -34°C to +41°C (extreme temperature for periods of between 6 hours and 7 days); and
- instantaneous temperature: -39°C to 46°C (extreme temperature for a 6 hour period).

A1 The envelope defined by the maximum and minimum temperatures is based on typical conditions in Europe.

See Chapter 2.4 Section 2.4.1.2.2.1
See Chapter 2.4 Section 2.4.1.2.2.2
See Chapter 2.1 Section 2.1.5

4/ The EUR Document Revision E - Content

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Volume 2 Chapter 2

PERFORMANCE REQUIREMENTS

Section	Requirement	Nuclear/Turbine/Common	Section comment	Last change
2.2 2.8.4	**Control range**			E-01
A	The minimum control range for secondary control operation should be ±10% of Rated Power*(P_r) above the minimum load taking into account the control range. Further details have to be defined in the agreement between system operator and plant Operator*.	C	A 1 The 10% can be achieved by the combination of the contributions from the NI and the PGP.	
2.2 2.8.5	**Variation rate**			E-01
A	The variation rate should be ± 1% of P_r/min.	C	A 1 The variation rate may vary for site specific plant due to the national TSO specifications	
2.2 2.9	**Scheduled and unscheduled load - following operation**			E-01
A	The Standard Plant* design shall allow the implementation of scheduled and unscheduled Load Following* operation during 90% of the whole fuel cycle.	C	A 1 This item deals with Load Following* variations, which occur as part of the daily load program. A 2 The Operator* of the plant defines the basic generation program of the plant based on the supply contracts. In addition the grid system operator can instruct the Unit* to participate in Load Following*, based on agreement. A 3 One load variation is defined as a drop in output followed by a plateau and an increase. A 4 Restrictions are due to fuel conditions at the end of the cycle. See Chapter 2.3 Section 2.3.3.1.1	

Requirement column

Comment column

4/ The EUR Document Revision E - Content

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Volume 2 Chapter 2

PERFORMANCE REQUIREMENTS

Revision E December, 2016

Section	*Requirement*	*Nuclear/Turbine/Common*	*Section comment*	*Last change*
2.2 2.8.4	**Control range**			E-01
A	The minimum control range for secondary control operation should be ±10% of Rated Power*(P_r) above the minimum load taking into account the control range. Further details have to be defined in the agreement between system operator and plant Operator*.	C	A 1 The 10% can be achieved by the combination of the contributions from the NI and the PGP.	
2.2 2.8.5	**Variation rate**			E-01
A	The variation rate should be ± 1% of P_r/min.	C	A 1 The variation rate may vary for site specific plant due to the national TSO specifications	
2.2 2.9	**Scheduled and unscheduled load - following operation**			E-01
A	The Standard Plant* design shall allow the implementation of scheduled and unscheduled Load Following* operation during 90% of the whole fuel cycle.	C	A 1 This item deals with Load Following* variations, which occur as part of the daily load program. A 2 The Operator* of the plant defines the basic generation program of the plant based on the supply contracts. In addition the grid system operator can instruct the Unit* to participate in Load Following*, based on agreement. A 3 One load variation is defined as a drop in output followed by a plateau and an increase. A 4 Restrictions are due to fuel conditions at the end of the cycle. See Chapter 2.3 Section 2.3.3.1.1	

Last update of the section (version of the EUR document)

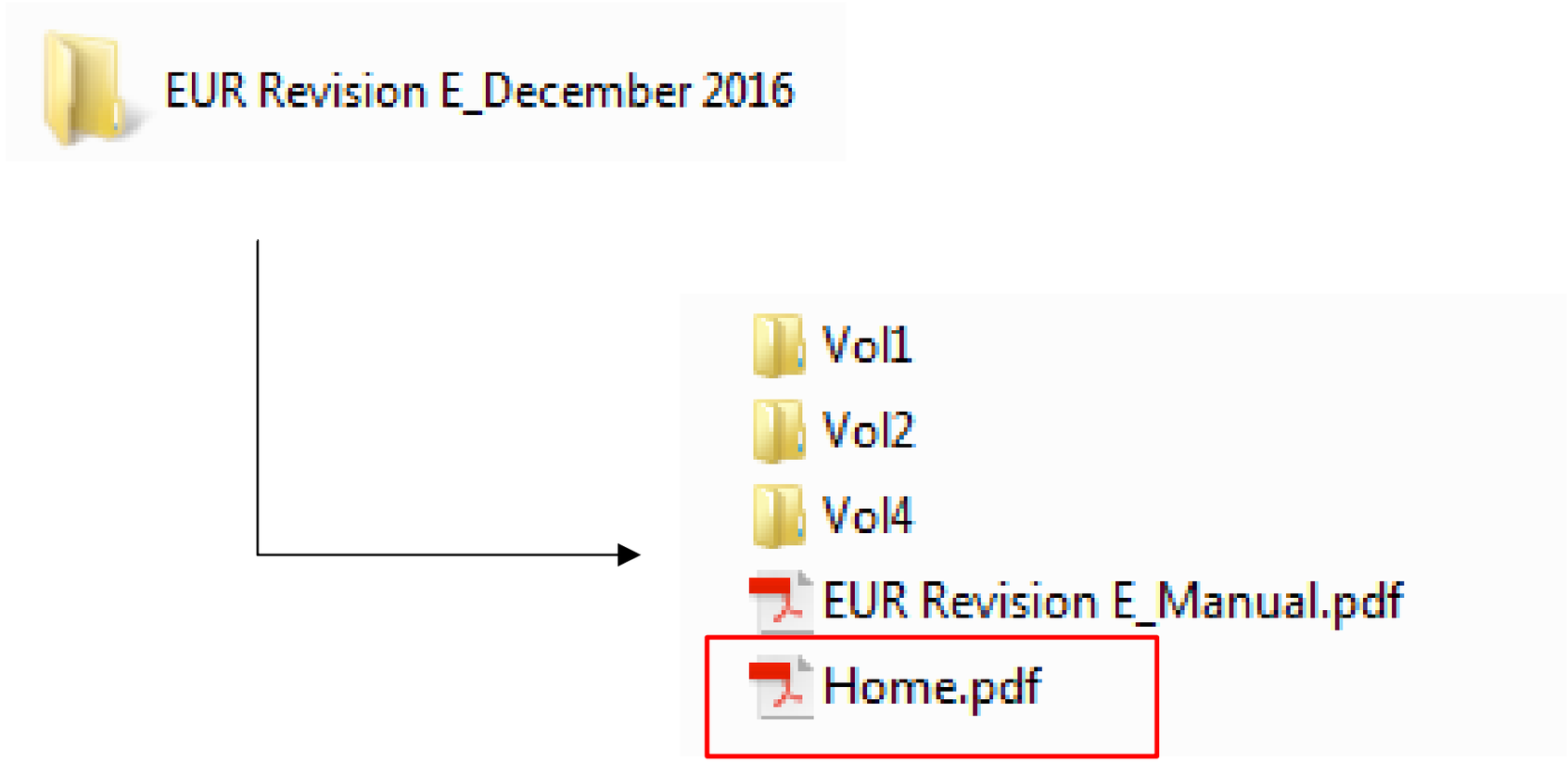
Tagging column

Nuclear Turbine Common

EUROPEAN UTILITY REQUIREMENTS FOR LWR NUCLEAR POWER PLANTS

4/ The EUR Document Revision E

How to use it ?



4/ The EUR Document Revision E - what's new ?

- **Revision E project in a few figures :**
  - **3 years duration (January 2014 – December 2016)**
  - **16 EUR utilities involved**
  - **98 EUR Experts (Safety, I&C, Systems, Layout, Grid, Material,..)**
  - **~ 1800 pages and 5500 requirements revised**
  - **2 additional chapters (Volume 1) compared to Revision D**

4/ The EUR Document Revision E - what's new ?

Volume 2 : Generic and NI requirements		
Chap.	**item**	**#page**
2.1	Safety	180
2.2	Performance	36
2.3	Grid	30
2.4	Design Basis	140
2.5	Codes & Standards	16
2.6	Materials	43
2.7	Components	120
2.8	Systems & Processes	180
2.9	Containment	122
2.10	I&C & HMI	112
2.11	Layout	132
2.12	Design Processes & Documentation	46
2.13	Constructability & Commissioning	41
2.14	Operation, Maintenance & Procedures	59
2.15	Quality Assurance	14
2.16	Decommissioning	16
2.17	PSA	58
2.18	Performance Assessment	35
2.19	Cost Assessment	15
2.20	Environmental Impact	23

Volume 1: Main Policies and Objectives		
Chap.	**item**	**#page**
1.1	Introduction	21
1.2	Policies	13
1.3	Synopsis	08
1.4	EUR 53 key issues	35
App A	Acronyms	15
App B	Definitions	34

Volume 4 : Specific PGP requirements		
Chap.	**item**	**#page**
4.1	Introduction to the Volume 4	13
4.2	Main turbine generator systems	96
4.3	Steam, condensate and feed-water system	63
4.4	Electric Power systems	43
4.5	Circulating water systems	29
4.6	Auxiliary systems	53

New Chapters / New text for Revision E

Chapters with major updates for Revision E

4/ The EUR Document Revision E - what's new ?

Overview of the main developments

- **Volume 1 (Main Policies and objectives):**

  - **Introduction of 5 EUR Policies (Chap 1.3):**
    - ✓ Safety
    - ✓ Economics
    - ✓ Environmental protection
    - ✓ Operational performance
    - ✓ Human factors

  - **Introduction of the EUR Key issues in Volume 1 (Chap 1.4) :**
    - ✓ **55 key issues for Revision D**
    - ✓ **53 key issues for revision E (75% are new)**
    - ✓ **Regrouping the most important requirements (~190) to be used for a new design pre-assessment**
    - ✓ **Objective of the Key issues is to evaluate the new design against 53 important issues before launching the full EUR Assessment (4000 requirements)**

4/ The EUR Document Revision E - what's new ?

Overview of the main developments

- Example of key issues

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Volume 1 Chapter 4

EUR KEY ISSUES

Revision E *December, 2016*

N°	Topic	Section - Requirement	Text of the key issue
3	Severe Accidents	2.1.2.4.2 A-B-C-D-E	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 objectives are met. 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. 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. 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. 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*.
4	Reference Source Term and PSA Evaluation of Source Term	2.1.2.4.3.2 A-B-C	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. The reference Severe Accident* should be included in Volume 3. 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. 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.
		2.1.2.4.3.4 A-B	Before PSA is finalised, engineering judgement may be used to identify the adequate reference sequence, even if the second probabilistic target (cumulative frequency of exceeding the CLI) would be met only with preventive measures.

4/ The EUR Document Revision E - what's new ?

Overview of the main developments

- **Volume 2 (Generic and Nuclear Island requirements):**

  - **Safety (Chap 2.1): New structure, based on IAEA SSR 2/1 structure :**
    - **Safety requirements:** improved coherence with international standards such as EURATOM Directives, WENRA Standards, IAEA Standards and guides, ..
    - **Safety classification** : new approach in line with IAEA SSG-30
    - **Radiological impact**: new safety objectives in line with WENRA definitions

  - **External Natural Hazards (Chapters 2.1 and 2.4)**:
    - **New approach based on 2 levels of magnitude** : Design Basis (DBEH) and Rare and Severe External Hazards (RSEH)
    - **SEISMIC** : fully revised sections

  - **I&C (chap 2.10):** update fully in line with IEC standards (61513, 60880, 62138, 61226)

  - **PSA (chap 2.17):** update of EUR chapter in line with IAEA SSG-3 and SSG-4

  - **Grid Connection (chap 2.3):** update in line with the new ENTSO-E Grid Code (06/2015)

  - **Pipe Break (chap 2.4):** update of Break Preclusion and Leak Before Break concepts

  - **Layout (chap 2.9):** update based on up-to-date international standards and standards

4/ The EUR Document Revision E
How to get it ? (1/2)

- **Distribution rules for Revision E Document**

  ✓ **Public access:**

  - Free access to the EUR Document Volume 1,
  - To any requester through the EUR public website.
    www.europeanutilityrequirements.eu

  ✓ **EUR "Members" access:**

  - Free access to the full package (Volumes 1, 2 and 4),
  - For the "EUR members" (Full and Associated members),
  - Through the EUR website with individual password or through the internal utilities' intranete (with Control of access Rules to be ensured inside each EUR utility).

  ✓ **Contractors of EUR "Members":**

  - Contractors will be provided with access to the EUR Document by the contracting EUR member, but access only for the contract purpose and its duration.
  - A NDA (Non - Disclosure Agreement) is to be included inside the contract and will have to be signed between the contracting EUR member and the contractor.

4/ The EUR Document Revision E How to get it ? (2/2)

	Stakeholder	Distribution & Rights of use	Fees/contribution/conditions
1	Any requester	Volume 1 for Information only (no commercial use).	- No Fees, Requester registration on EUR public website mandatory.
2	EUR Full Member Utility	Volumes 1, 2 and 4, for any use : - internal use (information, training, evaluations), - own requirements and own call of BIDs, - engineering or support services to Third Party*.	- Financial contribution to EUR annual expenses and In-kind contribution to EUR activities.
3	EUR Associated Member Utility	Volumes 1, 2 and 4 for own utility use only : - internal use (information, training, evaluations), - own requirements and own call of BIDs only.	- Effective in-kind contribution to EUR activities or, - Equivalent financial contribution.
4	EUR Observer Member Utility	Volumes 1, 2 and 4 for own utility use only : - internal use (information, training, evaluations), - own requirements and own call of BIDs only.	- Membership fees: 50 000€ (in 2022): 30 000 € at application stage and then 4 000 € during five years
5	Non EUR Member Utility	Considered as Profit Making Organisation (Rule 9).	
6	Vendor, for assessment purposes only	Volumes 1, 2 and 4 for assessment purposes only.	- Free of charge- “Rights of use for assessment purposes only and NDA” to be signed by a senior representative of the Vendor.
7	Vendor, for commercial use	Considered as Profit Making Organisation (Rule 9).	
8	Non Profit Making Organisation	Volumes 1, 2 and 4, for information only.	- Free of charge (no commercial use allowed). - “Rights of use for information only and NDA” to be signed by a senior representative of the Organisation.
9	Profit making Organisation	Volumes 1, 2 and 4, for any use : - internal use (information, training, evaluations), - own requirements and own call of BIDs, - engineering or support services to Third Party*.	- Royalty fee: 100 000 € (in 2022). - “Rights of use for any use and NDA” to be signed by a senior representative of the Organisation.

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Appendices

The EUR Document : Origin and evolutions

The EUR Document over time