

European Utility Requirements: common rules to design next LWR plants in an open electricity market

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Abstract – *The major European electricity producers want to keep able to build new nuclear power plants and they believe 3rd generation LWRs would be the most adapted response to their needs in the first decades of this century. Producing a common European Utility Requirement (EUR) document has been one of the basic tasks towards this objective. In this common frame, standardized and competitive LWR NPPs could be developed and offered to the investors. This idea is now well supported by all the other actors on the European electricity market: vendors, regulators, grid managers, administrations although in the competitive and unified European electricity market that is emerging, the electricity producers' stakes are more and more different from the other electricity business actors'. The next term objectives of the electricity producers involved in EUR are focused on negotiating common rules of the game together with the regulators. This covers the nuclear safety approaches, the conditions requested to connect a plant to a HV grid, as well the design standards. Discussions are going on between the EUR organization and all the corresponding bodies to develop stabilized and predictable design rules that would meet the constraints of nuclear electricity generation in this new environment. Last point: there cannot be competition without competitors. The EUR organization has already proven to be the right place to establish confident relationship between the vendors and their potential customers, mainly by assessing the level of compliance of their designs vs. the utility needs expressed in EUR. This will be continued and developed in the same fair manner as before with the main vendors present in Europe, so as to keep alive a list of 4 to 6 designs "qualified" vs. EUR..*

1 Introduction

The reasons for which the major European electricity producers want to keep the nuclear option open, are diverse: diversity of supply, evolution of the costs of alternative energies, Most of the European electricity producers would like to be able to build new nuclear power plants when their economic interest or necessity requests it. Producing a common specification, the European Utility Requirement (EUR) document, that sets out harmonised design targets is one of the basic tasks towards this objective. On this base the main vendors develop advanced LWR standard designs adapted to the European market, that can be built in the different countries without any major design change.

2 Background

The early drafts of the EUR document were produced in 1992, together with the last steps of development of the EPRI URD. Since that time, the scope of the EUR document has been progressively broadened -more topics and more designs addressed- while its bases have been strengthened. After more than 12 years of development and checking, the EUR document is now complete. All the parts of the EUR document that were foreseen in the initial action plan have been produced and a large part of the document has been updated one or two times.

In its current stage it actually is fully operational. It has been used as the technical specification for the call for bids of the fifth Finnish unit. It has also been used by the NPP vendors willing to develop LWR designs for Europe. It will, of course, be further improved to follow up the progress of technology and the constraints coming from Europe's integration as this is explained below.

Meanwhile the EUR organisation progressively grew from the 5 founder parties in November 1991 to 11 parties in December 2003, when Rosenergoatom, the Russian nuclear generator, has been welcomed as full member. As of today, the EUR organisation involves a strong majority of the nuclear electricity generators in Europe. Together they operate about 120 LWR units (PWRs and BWRs) in Europe. The several other European nuclear generators that currently do not participate will eventually be invited to join the EUR organisation.

3 The EUR document

3.1 Structure Of The EUR Document

The EUR document is structured into four volumes:

- Volume 1 (Main policies and objectives) defines the major design objectives and presents the main policies that are implemented throughout the EUR document.
- Volume 2 (Generic nuclear island requirements) contains all the generic requirements and preferences of the EUR utilities for the nuclear island.
- Volume 3 (Application of EUR to specific designs) is divided into a number of subsets. Each subset is dedicated to a specific design that is of interest to the participating utilities. A subset includes a description of the design and an analysis of compliance vs. the generic requirements of Volume 2. It may also include design dependent requirements.
- Volume 4 (Power generation plant requirements) contains the generic requirements related to the power generation plant.

The whole EUR document includes about forty chapters and 4000 individual requirements that deal with all the topics a utility has to address to have a nuclear power plant developed and built.

3.2 Status Of The EUR Document

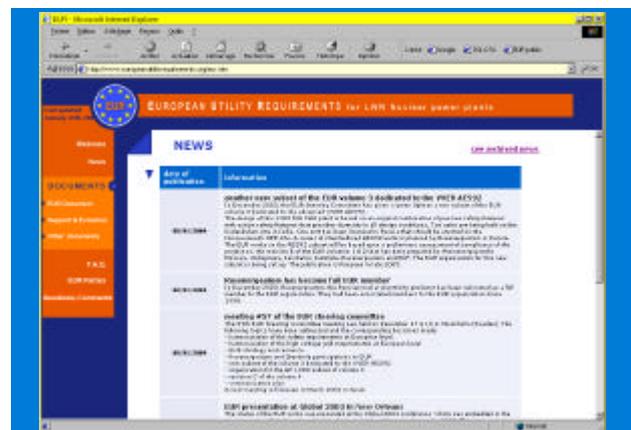
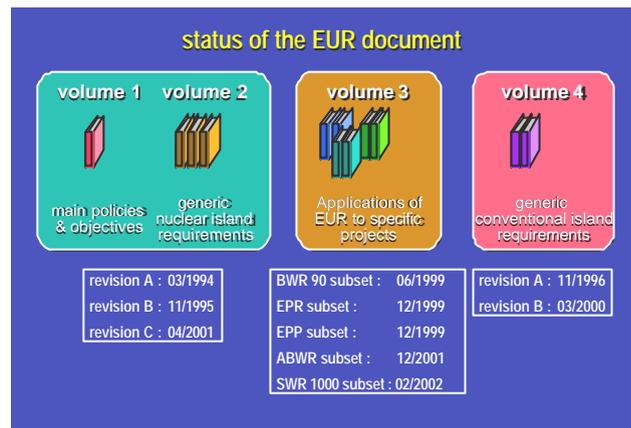
Volume by volume the situation is as follows:

Volumes 1 and 2:

The most recent state (revision C) has been released in April 2001. The bases for this revised version were:

- the results of the review of the main chapters of revision B by a group of European safety regulators,
- comments produced from in-depth reviews of the previous revision by the EUR organisation.
- the will to rewrite completely a few chapters that were either felt a bit outdated (chapter 2.10: "I&C and man-machine interface" and chapter 2.3: "HV transmission grid requirements") or not specific enough to allow the development of standard designs (chapter 2.11: "layout rules")
- the outcome of the analyses of compliance of the different projects addressed in EUR volume 3. During the production of the different subsets of volume 3, the generic EUR requirements have actually been tested at detail level vs. real designs. Thus many requests for further investigation, clarification and proposals for changes have been listed about important requirements.

The EUR organisation has been busy with the clarification and investigation works in 1998 and 1999.



The proposals for evolution, related to volumes 1 and 2, have been reconciled in 2000. Then a complex discussion and review process has been necessary to come to a consensus on all issues and to check the overall consistency of the document.

The corresponding texts have been dispatched world-wide, on paper in April 2001, on CDROM in July 2001 and on the Internet in September 2003. (see the EUR public site at: <http://www.europeanutilityrequirements.org>)

Volume 3:

Beside the sets of generic requirements of volumes 1 and 2, the EUR promoters are producing evaluations of selected LWR designs that may be offered on the European market. Brought together, they make up volume 3 of the EUR document. Five subsets have been published between 1997 and 2002.

A subset includes a description of the standard design and an analysis of compliance vs. the generic requirements of Volume 1 and 2. It may also include design dependent requirements. A subset of volume 3 is produced with contribution of the corresponding vendor. As of today, 5 subsets dedicated to the GE's ABWR, to the Westinghouse's BWR90 and EPP projects, and to the Areva's EPR and SWR1000 projects have been published. The decisions to undertake two new subsets of the volume 3, dedicated to the Westinghouse's AP1000 and to the Russian advanced VVER AES 92 have been made in 2003.

The works on volume 3 have actually been more in-depth and longer than initially planned. Since the analyses of compliance have been carried on to the elementary requirement level, they have requested much resource and time, both by the EUR utilities and by the interested vendors. On the other hand these detailed assessments of compliance vs. EUR have resulted in a kind of "qualification" of the volumes 1 and 2 vs. a panel of rather diverse real projects.

Another very positive fallout has been the involvement of the main vendors, that have gotten an in-depth knowledge of the EUR document, including the background rationales that do not appear explicitly in the text, and that were given opportunities to discuss the most critical issues. As the sixth and seventh subsets of volume 3 are being drafted, there obviously is a much better understanding between the European utilities that develop EUR and the NPP vendors that plan to be present on the European market in the ten coming years.

Volume 4

Several non-EUR utilities and the vendors have reviewed the revision A of the EUR volume 4 between 1997 and 1999. Their comments have been taken into consideration by the EUR organisation to write a revision B of the EUR volume 4 that was published in March 2000.

4 interaction with the European Safety regulators

4.1 Interaction with WENRA

In March 2003, WENRA, the Western Europe Nuclear Regulator Association, released a first version of a "Pilot Study on Harmonisation of Reactor Safety in WENRA countries" (see reference [1]) in which 6 important Safety Issues were addressed. For each of the themes addressed in their Pilot Study, WENRA established "Reference Levels" that summarise the regulators common position on this topic.

The EUR organisation eventually decided to analyse these Reference Levels with regard to the last published issue of the EUR safety requirements, the revision C of volumes 1 and 2 (see reference [2]).

The two documents have not the same objective. The WENRA Pilot Study aims at operating nuclear plants, while the EUR document defines a common specification for the development, design and construction of the next LWR European plants. The WENRA Pilot Study is focused on safety while the scope of EUR is broader. Considering that the safety of new plants should be commensurable with the safety of older plants operating at the same time, the EUR organisation quickly made the decision to enter a detailed comparison process that could be useful for both the EUR organisation and WENRA.

A major difficulty has been the different scopes of the two documents. There are numerous requirements in the WENRA Pilot Study dealing with organisation in operation and procedures, which have no counterpart in the EUR document. When the design is addressed, the requirements of the Pilot Study look relevant for new plants, but this may be misleading since the WENRA Pilot Study has been written for existing plants, thus implicitly limiting the requested changes, as compared to what could have been fore-seen on a new plant. Finally the Pilot Study has been written from a Regulator stand-point, setting out safety requirements stemming from protection of individual and public health while EUR lists design objectives from the owner to the designers that may en-compass constraints other than safety, like protection of the investment and profitability.

In spite of these differences it has been considered useful to work out a detailed comparison of the WENRA Pilot Study vs. the last version of EUR:

- So far the Pilot Study is the only harmonised reference text on safety written by Regulators and tailored for Europe.
- One can discuss whether the safety objectives should not be the same for new plant and for operating plants, even if more design options are possible on new plants. At the safety objectives level, the WENRA Pilot Study could actually be a relevant safety reference for new plants.
- The findings of such a comparison could be used for the next revision of the safety related parts of the EUR volumes 1 & 2, together with other comparison works being carried out by EUR (comparison with the IAEA requirements & guides, comparison with the USNRC regulations, etc...).
- A positive interaction between the group of investors / operators involved in EUR and the group of regulators involved in WENRA was sought.

Even if the WENRA Pilot Study released in March 2003 only includes 6 Safety Issues, the results of the analysis are rather rich and already show a few major differences, which stem:

- from the different perspectives: Regulators' vs. Utilities' standpoint,
- from different basic principles of the safety policies,
- from the fact the WENRA Pilot Study sometimes requests less radical evolution than the EUR, because it addresses already-built plants.

This analysis could be continued as the WENRA Pilot Study is being continued. A stronger interaction will be sought with the regulators to understand better each other and to limit the differences between a future version of EUR and the final WENRA Pilot Study to what is necessary to express the two different standpoints.

4.2 Other works about safety harmonisation

Meanwhile the European Commission keeps pushing the idea of harmonisation of the rules that govern nuclear plant design and operation. European texts may be issued in 2004 that bring support to the harmonisation works already undertaken by WENRA and EUR.

Other comparison works are being carried out by the EUR organisation to make sure the European rules do not deviate too far from a global "main stream". These are:

- A comparison between the EUR document and the IAEA guides and requirements,
- A comparison between the EUR document and the US regulations related to safety.

From this material, a draft revision D of the EUR chapters dealing with nuclear safety could be proposed in 2005 or later. It would be in line with the latest common European regulatory requirements on safety.

5 Interaction with the HV transmission grid regulators and operators

5.1 European background

Up to the mid 90's the European high voltage transmission grids had been built progressively, in national frames with limited cross-border exchanges. The European HV grid was divided in 3 main blocks (plus smaller isolated areas) managed independently from each other and not synchronised to each other.

- Western continental Europe managed by UCTE

- The Nordic countries managed by Nordel
- IPS/Centrel for Central Europe and the former USSR

Since the mid 90's two major events occurred that changed the environment in which these HV grid had been developed:

- The USSR collapsed, thus leaving the central Europe countries free to join the EU. The UCTE area grew Eastwards up to Poland and Romania. (see the opposite picture)
- The EU electricity market became a reality. New actors appeared on this huge electricity market that did not exist before: regulators, HV grid operators, traders, ... Electricity exchanges through the borders grew since there were large generation cost differences between the different areas and market actors were present in different countries.

In spite of this new frame, the erection of new transmission lines keeps very difficult and the trans-border exchanges are still severely limited by the capacity of the lines that had been designed for another environment. Only a progressive harmonisation of the conditions requested to connect the plants to the HV transmission network can eliminate important distortion in competition.

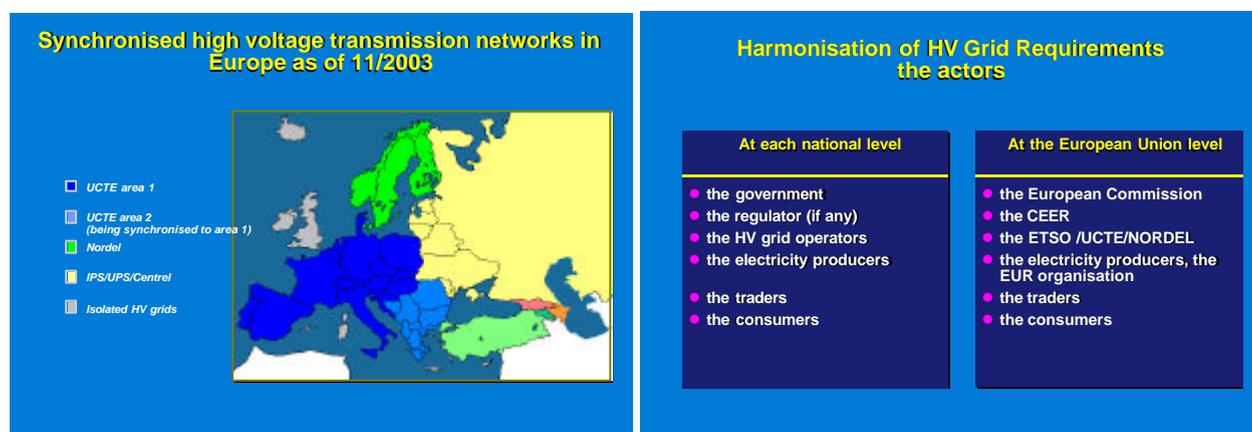


Figure 3

The European HV grids in 2004

Figure 4

The actors involved in HV grid requirements harmonization in Europe

5.2 The EUR organisation objectives

The investment cost differences due to the differences between the local HV grid regulations to connect a new LWR plant are significant. The stakes are almost as high here than on nuclear safety (several percents of the total investment cost).

In June 2003, the EUR organisation restored its topical working group on HV grid requirements and started to work in three directions:

- Comparison of the already issued or drafted national grid codes with EUR chapter 2.3 revision C and assessment of the impact of these differences on the designs
- Elaboration of a Background Report including results of the above review and proposal for the main changes of chapter 2.3
- Discussion with the other actors, mainly the grid operators and the regulators both at national level and at European level

From this material it is planned to draft a revision D of the EUR chapter 2.3 "Grid requirements" that would fit better the new European environment while keeping acceptable to the electricity generating companies that foresee to build new LWR plants.

6 Interaction with the vendors

The interaction between the EUR organisation and the vendors is achieved mainly through the volume 3 which will ultimately list 4 to 6 LWR designs assessed as acceptable by the European electricity generators for their next LWR plants.

In 2003, decisions were made by the EUR organisation to undertake two new subsets of volume 3:

- a new subset of the EUR volume 3 dedicated to the Westinghouse AP1000 standardised nuclear power unit. This PWR plant with passive safety features delivers 1000 MW but only includes 2 steam generators, as the already certified AP600. The USNRC certification of the AP1000 is foreseen in 2004. The EUR works on the AP1000 subset will be based upon a preliminary assessment of compliance of the project vs. the revision C of the EUR volumes 1 & 2 that is being produced by Westinghouse, Ansaldo, EDF and the Swiss nuclear utilities associated in a new phase 2D of the European Passive Plant (EPP) project. The publication of the new subset is foreseen in late 2005.
- a new subset of the EUR volume 3 dedicated to the advanced VVER AES92. The design of this 1000 MW PWR plant is based on an original combination of passive safety features with active safety features that provides diversity in all design conditions. Two units are being built on the Kudankulam site in India. One unit has been licensed in Russia that should be erected on the Novovoronezh NPP site. A series of standardised AES92 units is planned by Rosenergoatom in Russia. The EUR works on the AES92 subset will be based upon a preliminary assessment of compliance of the project vs. the revision B of the EUR volumes 1 & 2 that has been prepared by Atomenergoproekt Moscow, Gidropress, Kurchatov Institute, Rosenergoatom and EDF. The publication is foreseen in late 2005 or early 2006.

About the other subsets of the EUR volume 3, nothing has been undertaken in 2003. It is planned to check each of the already published subset of volume 3 with the interested vendor to see:

- whether this subset should be updated due to the evolution of either the design or the EUR document
- whether the vendor still support this design. In case a design would be deemed obsolete or the vendor would no longer support it, the corresponding subset of the EUR volume 3 would be labelled non applicable and archived.

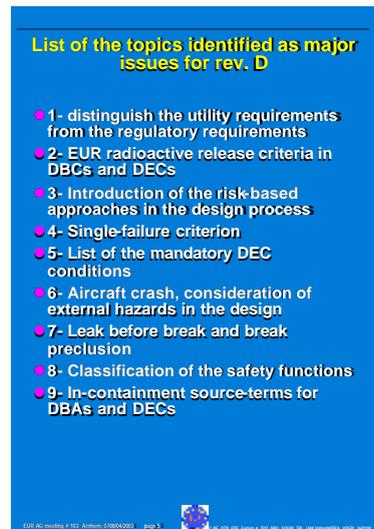
7 Internal review works

7.1 Background and methodology

While the EUR organisation organised dialogues with the regulators, the vendors and their other partners in electricity business that may influence the design of the future plants, they carried out a thorough review of the key chapters of the EUR volumes 2 and 4.

These reviews started in early 2002 and lasted up to September 2003. The following objectives had been given:

- eliminate the duplicated parts (between volume 2 and volume 4).
- improve neutrality by rewriting the texts in a less solution-oriented way
- keep functional requirements only, as far as possible
- clarify the text: more rationales, elimination of the obscure requirements, self-standing texts
- check consistency between volume 4 and revision C/D of volumes 1 & 2



Figures 5 & 6
Identified issues for the
revision D of the volumes 1 & 2

7.2 *Review of Volume 2*

From the reviews, a set of background reports was produced that recommend detail modifications of the text of revision C. They will be used when the revision works start.

Beyond those detail modifications a list of major technical issues has been produced that should be resolved before the next revision of the EUR volume 2 is issued. The two following pictures give the headlines of the identified issues.

7.3 *Review of Volume 4 and preparation of the next revision*

On volume 4, the same approach was followed. Background reports were produced for the main chapters and the EUR coordination group for volume 4 was restored. This group of specialists from the EUR utilities drafted a revision C of the volume 4 in 2003 and 2004. Following this internal review the text has been updated and brought into consistency with the revision C of the volumes 1 and 2. The revision C of the EUR volume 4 should be published later this year or at the beginning of next year.

8 **next steps – short term programme**

From the actions listed above it is quite easy to rebuild the short term programme of work of the EUR organisation.

It can be organised along the following 5 lines:

- Communication with the outer partners: communication in the major conferences, the nuclear magazines and the Internet
- Paving the way to a revision D of volumes 1 & 2 by working on harmonisation of the European rules with the other actors and resolving the issues identified from the internal reviews of the EUR document
- Keeping volume 3 updated by working out two new subsets dedicated to AP 1000 and AES 92 while checking the validity of the already published subsets with the vendors.
- Preparing a revision C of the volume 4.
- Keeping collaboration alive with the non-European actors

Most of these objectives look achievable by 2006 – 2007.

9 **a longer term perspective**

In the longer term the question of the perpetuation of the EUR organisation must be raised. Such an organisation has proved efficient to develop a common specification and may well be used for other purposes.

A reflection round is engaged at the EUR Steering Committee level and at each participating utility to see what could be the optimal organisation.

10 **conclusion**

Collaboration with the other actors of the nuclear business is the key item of the EUR strategy for the coming years. The EUR document has been developed for Europe by the European Utilities. The nuclear market is not actually regional but global for several reasons: (i) the development costs are too high to allow developing specific designs for a specific area, (ii) there is a small number of designers/vendors, (iii) the rules of the game are getting harmonised world-wide.

The European utilities plan to interact with all the other actors that may be influence design and design requirements, especially:

- the regulators
- the grid operators
- the vendors
- those utilities that produce URDs or that intend to use existing URDs to produce NPP specifications

The ultimate objective keeps the same as in the initial steps of the EUR works: to offer a stabilised and predictable environment to the vendors to allow them to develop standard designs that fit the needs of the utilities and do not

need to be redesigned for each new construction. We still think that, beyond what is being done in Europe in EUR, there is a supplementary benefit for all the utilities worldwide in harmonising their specifications for future NPPs.

REFERENCES

[1] Pilot Study on Harmonisation of Reactor Safety in WENRA countries, WENRA working group on Reactor Harmonisation, March 2003.

On the Web at the following address: http://www.asn.gouv.fr/data/information/14_2003_wenra.asp

[2] European Utility Requirement document, volumes 1 & 2, revision C, April 2001

On the Web at the following address: <http://www.europeanutilityrequirements.org>