

Convergence of Technical Safety Practices within Actual Projects and for the Benefit of the Operator: The Unique FRAMATOME ANP Experience

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Abstract

Over the last decade, the movement towards convergence of technical safety practices in Europe was mainly driven by

- Multi-national development of new power plant models
- International modernization and safety improvement projects of older plants in western Europe
- International projects for reconstruction or finalization of eastern European reactors, including safety enhancement
- European technical support programs and IAEA activities for eastern European reactors.

The presentation includes a brief description of the involvement of FRAMATOME ANP in those fields, which demonstrates the role of the company as a major global player in the field of nuclear technology.

About FRAMATOME ANP

FRAMATOME ANP merged the nuclear activities of Framatome SA and Siemens KWU in January 2001, consolidating the past experience of both companies, and including their respective engagements in the United States.

At present FRAMATOME ANP is organized in the following way:

- Framatome ANP SAS Headquarters and French Business Units
- Framatome ANP GmbH German Regional Division
- Framatome ANP, Inc. U.S. Regional Division

In May 2002, Duke Engineering and Services was incorporated as a further U.S. regional division under the name Framatome ANP DE&S.

The company, including its subsidiaries, has about 14 000 employees.

1 General

Over the last decade, the movement towards convergence of technical safety practices in the nuclear engineering field in Europe was mainly driven by:

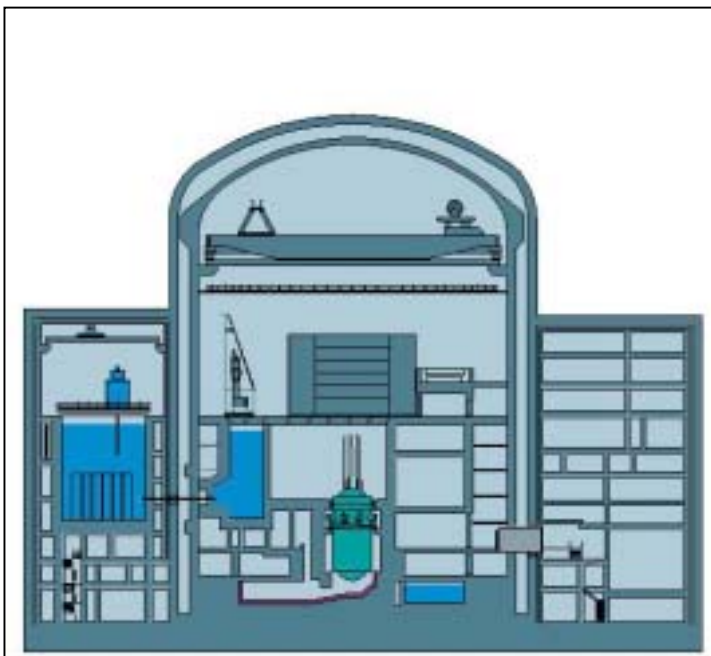
- Multi-national development of new power plant models (e.g. following the European Utility Requirements, like EPR and SWR 1000)
- International projects for modernization and safety improvement of older power plants in western Europe
- International projects for large reconstruction or finalization of eastern European reactors, including safety enhancement
- European technical support programs (e.g. TACIS and PHARE) and IAEA activities for eastern European reactors.

In the following chapters, a brief overview on the major contributions of FRAMATOME ANP in those fields will be given.

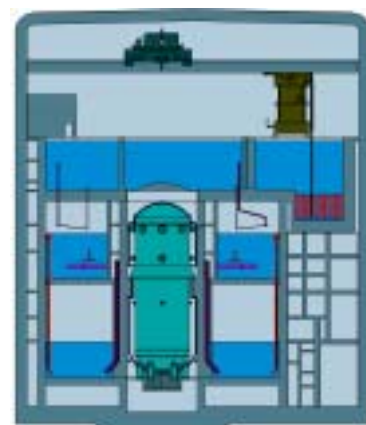
The international character of both, the technical requirements and the consortia or teams performing the activities, were a major driving force for exchange and harmonization of technical safety practices.

2 Development of new power plant models

FRAMATOME ANP has developed modern Pressurized Water Reactor (EPR) and Boiling Water Reactor (SWR 1000) power plants.



EPR European Pressurized Water Reactor



SWR 1000 Boiling Water Reactor

The plant designs are optimized for economical parameters, following the European Utility Requirements. Their safety status is very high, due to application of enhanced deterministic safety criteria. The safety features include technical provisions even for beyond-design basis and severe accident conditions. The design processes were accompanied by probabilistic safety analyses, in order to optimize the safety systems, and to justify the fulfillment of the PSA target values.

The European Pressurized Water Reactor (EPR) is a good example of inter-European harmonization. It was designed to include both, the French and German safety principles and advantageous design features, which in the previous PWR plants sometimes had shown very large differences in plant design and layout. Due to close cooperation with leading European power utilities (going even beyond EdF and German utilities), and due to involvement of French and German safety authorities and expert organizations (IRSN, DRS), an optimum balance of both, economical factors and a high safety status, could be reached.

The EPR, as well as the SWR 1000, are prepared for the certification process in the USA. Both reactor types will also be offered for the fifth unit in Finland.

3 Western European modernization projects

Safety enhancement and equipment modernization projects for reactors of their own design were and are still the major sources for a broad backfitting knowledge of FRAMATOME ANP.

Within international modernization projects this experience could be successfully transferred to reactors of foreign design, under consideration of the respective national technical and safety regulations.

Major reconstruction projects in this area, performed over the last years include:

- Borssele Modification Project, Netherlands
Comprehensive backfitting and safety enhancement
- Oskarshamn 1 MOD Project, Sweden
Modernization of safety systems, exchange of recirculation pump casings
- Beznau 1-2 NANO Project, Switzerland
Bunkered emergency heat removal system
- Beznau 1-2, Switzerland
Replacement of I&C and safeguard systems
- Forsmark 1-3, Sweden
Piping replacement and nozzle repairs, control rod indication and control system
- Doel 3-4, Belgium, SG replacement
- Tihange 1, Belgium, SG replacement
- Ringhals 2-3, Sweden, SG replacement
- Beznau 1-2, Switzerland, SG replacement
- Asco 1-2, Spain, SG replacement
- Krsko, Slovenia
SG replacement and spent fuel storage upgrading

4 Eastern European modernization and safety enhancement projects

Around the times of the re-unification of eastern and western Germany, upgrading studies and engineering projects were performed for all of the plants in operation or under construction in the former GDR, jointly with the power utility and the national design company (KKAB), and under involvement of the Russian main design institutes.

The projects included all of the three major generations of Russian PWR design:

- WWER 440 Model 230 – NPP Greifswald, Units 1-4
- WWER 440 Model 213 – NPP Greifswald, Units 5-8
- WWER 1000 Model 320 – NPP Stendal, Units 1-2

During those studies and projects the general basis for familiarization with the designs was laid, and the basic modernization and upgrading concepts were elaborated in our company.

In the following years a number of complex modernization and safety enhancement projects of eastern European WWER power plants have been or are being performed, mostly by international consortia, under major involvement of nowadays FRAMATOME ANP.

References of major WWER activities in Europe:

- NPP Bohunice V-1, Units 1-2, Slovakia
Within the consortium REKON (with local company VUJE) a major upgrading and safety enhancement program of the units of WWER 440-230 type was performed, including large re-design of safety systems and a total exchange of safety related control systems by a digital TELEPERM XS I&C system (finalized in 2000).
- NPP Mochovce, Units 1-2, Slovakia
The consortium EUCOM, including both partners of nowadays FRAMATOME ANP, was responsible for the major part of the safety enhancement measures, which were implemented during finalization of erection and commissioning of the units of WWER 440-213 type.
An upgraded plant control system, including safety I&C, part of operational I&C, as well as control room equipment and a simulator, were also parts of our deliveries (finalized in 1999).
- NPP Kozloduy, Units 5-6, Bulgaria
The major part of the comprehensive modernization and safety enhancement project of the units of WWER 1000-320 type is being performed by the consortium ECK, consisting of both partners of nowadays FRAMATOME ANP and the Russian ATOMSTROJ-EXPORT organization. The modernization activities are carried out with large involvement of Bulgarian engineering and erection companies (scheduled to be finalized basically in 2005).
- NPP Paks, Units 1-4, Hungary
The replacement of the reactor protection systems of the units of WWER 440-213 type by TELEPERM XS digital safety class I&C has recently been completed. Since 1999, beginning with Unit 1, every year a further unit started successfully operating with the new system.
The seismic analysis and improvement, another important project with major involvement of FRAMATOME ANP, was also completed recently.

- NPP Dukovany, Units 1-4, Czech Republic
The project of replacement of the reactor protection systems by SPINLINE 3 digital safety class equipment is presently under way at the units of WWER 440-213 type.
- NPPs Khmelnytsky 2 and Rovno 4, Ukraine
FRAMATOME ANP, as leader of a consortium with the Russian ATOMSTROJEXPORT organization, is currently finalizing the contract with the Ukrainian utility ENERGOATOM for completion, rehabilitation and modernization of the two units of WWER 1000-320 type. The scope covers mainly project management, detailed design and procurement of equipment still to be purchased, as well as erection and pre-commissioning works for installations remaining to be completed.
The contract is technically and commercially ready and initiated. Its finalization depends on the result of the on-going negotiations between Ukraine, the EBRD and EURATOM about the financing scheme.
- NPP Kozloduy, Units 3-4, Bulgaria
A stepwise modernization of the units of a modified WWER 440-230 type (enhanced safety systems providing 3 x 100 % redundancy were implemented in the original design) has been performed over the last 10 years. The presently finalized safety enhancement program led to a safety status which is similar to the current status of other nuclear plants of that age (confirmed by IAEA and several other expertise).
FRAMATOME ANP has so far – besides deliveries like diagnosis systems – performed assessments of the safety upgrading program and a comprehensive rest lifetime evaluation (in a consortium with ATOMSTROJEXPORT).
The plant operator has now issued a letter of intent to FRAMATOME ANP (in consortium partnership with ATOMSTROJEXPORT) for further technical and safety enhancement measures. Work items derived from the findings and proposals of the rest lifetime evaluation project, and some remaining measures of the modernization program (dedicated to beyond-design basis and severe accident management) are the major topics. Depending on the final decision about the plants' operational life times, a replacement of the safety related I&C systems of the units by a new digital system shall also be part of the project.

5 European and IAEA technical support programs for eastern European plants

FRAMATOME ANP has been and is still participating in numerous project items of the European TACIS and PHARE programs providing technical assistance to the countries of the former Soviet Union (TACIS) and to the eastern European countries (PHARE).

Many of those project items were performed in multi-national partnership of design companies, and under involvement of institutes and companies of the beneficiaries' countries.

Specialists of FRAMATOME ANP have been members of several working groups of the IAEA extrabudgetary program for assistance of the central and eastern European countries operating nuclear power plants of Russian design.

Within the program, plant specific safety review missions, reviews of operational performance, as well as topical meetings on generic safety issues, safety analyses and seismic safety studies have been performed.

Major general activities were the elaboration of

- generic safety issues and their ranking, separately for each type of Russian NPP,

- a set of technical guidelines for general and specific accident analyses of WWER plants,
- seismic re-evaluation guidelines for operating WWER plants.

Those activities involved international sharing and transfer of methodologies in several fields of nuclear safety.

6 Conclusion

Due to the international projects and engagements, which were briefly described before, the intensity of international co-operation, with its side-effect of discussion, explanation and sharing of technical safety practices, was remarkably increased over the last decade.

The resulting benefit of the plant operators out of our international projects is multiple:

- new or modernized equipment in accordance with up-to-date state of technology,
- safety analyses and proof of qualification based on actual and internationally accepted rules and standards,
- commitment that the technical safety status and safety practices are in harmony with internationally agreed principles.