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FINAL RESULTS OF THE GRADUAL RECONSTRUCTION OF BOHUNICE V1 IN SLOVAKIA AND EVALUATION OF THE RECONSTRUCTION BY INTERNATIONAL MISSIONS

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ABSTRACT

The gradual reconstruction of the Bohunice V1 nuclear power plant (Slovakia) represents the most extensive reconstruction of a nuclear power plant in operation as implemented worldwide up to now. Extensive reconstruction works in both civil construction and process parts, in instrumentation and control part, and in electric part enhanced both nuclear safety and operational reliability of Bohunice V1 in a significant way.

1 INTRODUCTION

The most extensive reconstruction of a nuclear power plant with VVER 440/V230 reactor and also the most extensive reconstruction of a nuclear power plant in the world at all was completed by the implementation of all the planned works at Bohunice V1 in the middle of 2000. Extensive reconstruction works (1996 ÷ 2000) in the field of process systems, electric part, instrumentation and control system and civil construction part, which upgraded its nuclear safety in a significant way, were implemented by Rekon consortium. The consortium - established on purpose for the action of the gradual reconstruction of Bohunice V1 - consisted of Siemens KWU and VÚJE Trnava, Inc. The gradual reconstruction was implemented based on the Decision No. 1/1994 of the Slovak Nuclear Regulatory Authority (ÚJD SR), which preconditioned subsequent operation of Bohunice V1 by requiring a gradual upgrading of nuclear safety up to the level accepted internationally.

Bohunice V1 unit 1 was commissioned in 1978 and unit 2 in 1980. These units – following the comprehensive reconstruction of their safety related systems – are now operated at a high level of nuclear safety and operational reliability.

In the period from 1993 to 2000, eighteen different missions visited Bohunice V1 and none of them recommended to close the units immediately (Appendix 1).

2 ORGANIZATION, IMPLEMENTATION AND EVALUATION OF THE PROJECT

2.1 Project organization

The activities associated with the reconstruction of each out of 16 functional process entities were implemented mainly during extended unit outages for refueling. The usual duration of unit outage (approximately 40 days) was extended up to 70 – 175 days according to the scope of planned works. It was in line with the global philosophy of the utility to implement reconstruction works gradually at units 1 and 2 in the course of individual outages without necessity to shut the units down for a long time. This policy is demanding on a thorough work planning and coordination during the outage and it was necessary to ensure:

- coordination of reconstruction works with other maintenance tasks
- coordination among all the professions involved (civil woks, process systems, electric parts, I&C) in the particular functional process systems.

2.2 Project implementation

The implementation works in the gradual reconstruction started during a refueling outage in 1996 and were completed during a refueling outage in 2000, i.e., during 4 outages at unit 2 and 4 outages at unit 1. Unit 1 was shut down for the comprehensive implementation of all the reconstruction works totally 373 days, unit 2 for 467 days. The average shutdown duration during 8 outages needed for the complete implementation of works was 105 days.

The most extensive scope of works was implemented during the outage of unit 1 in 2000, that means during the final phase of the gradual reconstruction. In this phase, works were completed in a similar scope as during the outage of unit 2 in 1998 and besides that works on essential service water were completed and final tests were implemented. In this phase, a positive effect of experience transfer from previous reconstruction phases was obtained in full scale (Appendix 2).

Since the beginning of the project, we tried to involve as many national firms as possible into the supplier system. Firstly, only firms with sufficient experience and with activities in nuclear sector were engaged into the whole project. Secondly firms were involved in the gradual reconstruction based on their histories and references giving good assumptions for meeting demanding tasks with regard to schedule, technically and organizationally. Even with a consistent selection of subcontractors, some of them were not able to meet high requirements on the quality required and on the schedule required by the customer.

Into the supplier system, firms with large experience and excellent references from the construction of nuclear units were chosen as main subcontractors. These firms – EZ - ES Electric Systems, Bratislava, PPA Control and VÚEZ Levice – have design and installation sections and contributed significantly to the successful progress of the whole action.

Active engagement of supplier employees in the whole process was another important factor affecting compliance with the high level of work. Supplier employees were working in groups for design preparation, they reviewed design and other documentation, and they cooperated in the preparation of schedules for the coordination of works related to the gradual reconstruction and normal maintenance during refueling outages.

The cooperation of plant operators in addressing issues related to the links between the newly installed advanced equipment and the equipment remaining in use even after completing the gradual reconstruction was very valuable.

The whole process of reconstruction was progressing under qualified oversight of the Nuclear Regulatory Authority (ÚJD) of the Slovak Republic (SR).

Qualified comments, recommendations and requirements of ÚJD SR staff contributed significantly to the safe progress of the gradual reconstruction.

3 PROJECT EVALUATION

The progress and results of the gradual reconstruction were evaluated continually in the course of implementation of the particular reconstruction measures and at the end of the gradual reconstruction. The most important evaluations are the assessments and conclusions form IAEA and WENRA missions.

Quotations from certain evaluations is given below:

3.1 IAEA mission (June 1988)

„When the gradual reconstruction of the Bohunice V1 will be completed, all the IAEA recommendations for VVER 440/230 reactors will be met.“

3.2 Convention on nuclear safety (April 1998)

„The exceptional result in the field of NPP safety upgrading on the side of both the regulators and industry (operators, suppliers, research) will make it possible for Slovakia to transfer the knowledge and experience to other countries with similar nuclear installations.“

3.3 Conclusions of the International Conference on Strengthening of Nuclear Safety in Eastern Europe (June 1999)

„Considering all planned and already implemented measures for safety upgrading, Bohunice V1 can be considered as an example of the safety level that can be achieved at VVER 440/V230.“

3.4 WENRA mission (October 1999)

„The extensive program for safety upgrading is close to completion. This program enhanced the reactor safety significantly. The operators carried out a significant progress to establish new design bases and to implement relevant measures. Some measures will still be necessary to perform, but no technical problems are envisaged. These measures will be completed in 2000.

When a solution related to the capability of confinement to cope with double-ended guillotine break of main circulation piping (LOCA), it may be expected that the safety level of these units will be comparable with units of the same age in West European countries.”

3.5 IAEA mission (November 2000) – mission after the completion of the gradual reconstruction

„The review team has the opinion that a comprehensive and well-justified program for safety upgrading has been developed and implemented at Bohunice V1. The program defines new design bases that meet the Slovak national requirements and in certain areas exceeds the framework of IAEA recommendations for safety upgrading of NPPs with VVER 440/230 reactors.

Defense in depth was improved significantly in a balanced way by implementing these measures. The top priority was allocated to preventive measures in general and mainly in areas where the possibility of modifications was limited.

Also the prevention of severe accidents with core melting was enhanced systematically by appropriate measures.

In the particular case of accidents caused by loss of coolant, safety functions for core cooling and the ability to maintain radioactive materials for the whole spectrum of primary pipe breaks up to the diameter of 200 mm are now met with conservative assumptions, and for piping with the largest diameter of 500 mm with best estimate assumptions in line with recommendations formulated by IAEA experts and accepted by the Slovak Nuclear Regulatory Authority.“

According to WANO evaluation using ten Performance Indicators for operational assessment of nuclear power plants, acknowledged worldwide and evaluated quarterly, „Bohunice V1 has achieved the results in the first better half of nuclear power plants in the world for a long time“.

4 CONCLUSIONS

The Slovak Nuclear Regulatory Authority issued on July 31, 2001 a license for the operation of Bohunice V1 for subsequent 10 years, i.e. till 2011. During the gradual reconstruction, the ÚJD SR used to issue licenses always for a single fuel cycle.

However, this Decision of ÚJD SR does not cancel the decision of the Slovak government according to which Bohunice V1 unit 1 will be closed in 2006 and unit 2 in 2008, i.e., before the planned lifetime expires.

From technical point of view, there is no reason for closing Bohunice V1, the plant is evaluated at high safety level and provides a safe and economically beneficial source of electricity.

Preliminary closure of the reconstructed Bohunice V1 plant before its lifetime expires would have a large negative economical and social impact on the whole region where the plant is sited.

The Bohunice V1 safety level achieved and the reduction of all economic losses following the closure should better lead to considerations how to prepare works for plant lifetime extension.

Will be the Bohunice V1 plant closed at the planned deadlines, or will be its operation extended in line with the worldwide trend?

REFERENCES

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Appendix 1

International Missions in Bohunice

	INSTITUTION	OBJECTIVES	DATE
1.	Siemens AG	Review of safety standards	8 to 11/90
2.	Commission of the Federal Government and Ministry of Environmental affairs of CSFR	Safety evaluation	8 to 11/90
3.	Austrian government Mission	Safety evaluation	8 to 10/90
4.	IAEA	Fact finding Mission	9/90
5.	IAEA - ASSET	Mission for review of serious operating accidents	10/90
6.	IAEA - DOSART	Mission for project review	4/91 & 4/92
7.	IAEA - ASSET	Subsequent Mission	7/93
8.	IAEA	Peer review Mission	3/93
9.	IAEA	Review of the „Small reconstruction“	7/93
10.	IAEA	Review of seismic upgrading	4/94
11.	IAEA	Review of RPV - Annealing	3/94
12.	IAEA	Application of the LBB/Concept	3/94
13.	IAEA	Status of gradual upgrading process	5/96
14.	IAEA	Status of gradual upgrading process	6/98
15.	IAEA	Review of seismic upgrading	11/98
16.	WENRA	Safety evaluation	10/99
17.	IAEA	Mission after the completion of the gradual reconstruction	11/2000

Appendix 2

SAFETY MEASURE IMPLEMENTATION SCHEDULE