



**Nuclear Power Plants Division
Dukovany NPP site**

**Equipment Renovation Program
Dukovany NPP
MORAVA**

Procedural Report

**ČEZ-NPD
April 2004**

Background

The drafting of the "*Back-fitting of Dukovany Nuclear Power Plant*" program, the main goal of which was to increase the level of nuclear safety, was already started during the commissioning of the individual units in the Dukovany NPP. The initial design of the Back-fitting was created in 1990 and in 1991 preparation and implementation of the individual activities was started. In the present time all major measures from this program are already implemented. A series of further activities, the aim of which was equipment renovation, was implemented also outside the "Back-fitting" program.

Since the beginning of the nineties the verification in-depth commenced to check the safety level of nuclear power plants constructed based on Russian design, and the efforts to put them out of operation increased in intensity. Regarding these trends, it became obvious that it would be necessary to perform a complex evaluation of the real situation in the Dukovany NPP. A series of analyses and supporting programs was carried out in the frame of international activities and within the Czech republic. Assessment of the Dukovany NPP was performed both by own experts from the Dukovany NPP and by independent (mainly foreign) experts. For instance experts from the International Atomic Energy Agency (IAEA), experts from nuclear power plants in operation from different countries, experts from the regulatory bodies (Czech and foreign), experts from the manufacturers of nuclear power plants equipment, etc. were involved in the assessment.

Concept of the **Equipment Renovation Program**, which was later named **MORAVA** (**MO**dernization - **Re**construction - **Anal**yses - **VA**lidation), was based on an extensive technical assessment of the Dukovany NPP (technical audit), the goal of which was to evaluate the actual situation of the Dukovany NPP and to propose a list of necessary modifications, which would form a basis for the equipment reconstruction in the next period of time.

The Dukovany NPP audit was split in two parts:

A) **Internal audit**, carried out by teams of about 100 Dukovany NPP employees with the support of external organizations (ÚJV ŘEŽ, 3E Praha and others), evaluated the equipment from five viewpoints:

1. Equipment reliability and its impact on nuclear safety
2. Failure rate of the equipment and its impact on the NPP availability (impact on the production outages)
3. Equipment requirements for maintenance
4. Residual lifetime of the equipment and spare parts status
5. Further impacts, not included in the above (radiation protection, fire protection etc.)

B) **External audit** – within the PHARE project, the ENAC consortium has performed an independent assessment of the technical security of the Dukovany NPP from the viewpoint of international standards and nuclear safety principles.

This step has represented the first verification of the proposed scope of modifications in the Dukovany NPP.

IAEA mission aimed at assessing approach of the Dukovany NPP to the solution of the so-called Safety issues (described by IAEA for VVER 440/213 within the off-budget program (publication IAEA-EBP-WWER-03).

To assess the level of operation many international missions were organized since 1989 (see below).

Main milestones and program starting points

The main milestones for the determination and specification of Equipment Renovation Program and its control, performed both by own efforts or using international support are listed below:

- 1990 – Drafting of the "Initial design of the so-called Back-fitting", i.e. modernization based on the resolution of the government of the ČSSR No. 309 (November 20, 1986) with the main goal to increase nuclear safety;
- 1991 – Creation of an Engineering Services Center in ČEZ-Dukovany NPP;
- 1991 – Commencement of activities included in the Back-fitting program;
- 1991 – Assessment of the conclusions in the so-called "Green Paper" (safety evaluation of the NORD NPP in the former GDR – Dukovany NPP team);
- 1992 – Common activities of the VVER 440/V213 units operators (list of safety improvements, Dukovany NPP representatives, members of the VVER 440/213 club);
- 1994-95 Internal technical audit (Dukovany NPP working teams, support from ÚJV ŘEŽ);
- 1995 – External technical safety audit (ENAC consortium – PHARE program);
- 1995 – Safety Report, updated after 10 years of operation (Škoda Praha);
- 1995 – Probabilistic Safety Assessment (Dukovany NPP team and ÚJV ŘEŽ, further living PSA);
- 1996 – Finalization of the Back-fitting program (most of the activities were carried out, the remaining ones were included into the Equipment renovation program);
- 1996 – Triangular agreement on cooperation and technical information exchange among Dukovany NPP, Bohunice NPP, and Mochovce NPP (exchange of information about modernization measures);
- 1996-99 Composition and validation of the Emergency Operating Procedures (EOPs – created by the Westinghouse company) – analyses conclusions resulted in recommendation for modifications;
- 1997 – Evaluation of the conclusions of technical evaluations and missions;
- 1998 – Drafting of the Equipment Renovation Program documentation (Dukovany NPP team and ÚJV ŘEŽ, EGP Praha);
- 1999-2000 – Implementation of the Preliminary Feasibility Study (Dukovany NPP team and EGP Praha);
- 2001 – Organizational change in ČEZ-Dukovany NPP in the area of modifications control (creation of the technical engineering center and transfer of the investments preparation and implementation to the Maintenance and Repairs Department);
- 2004 – Establishment of the Nuclear Power Plants Division (common organizational structure for Dukovany NPP as well as for Temelín NPP).

SÚJB requirements from the Decision for units 1 to 4 and other supporting evaluations were further inputs to the Equipment Renovation Program.

Since 1990, supporting PHARE (EU) programs are also used.

To verify the Dukovany NPP approach, independent evaluations have been used (the main ones being):

- 1989 – OSART (IAEA) mission
- 1991 – RE-OSART (IAEA) mission
- 1993 – ASSET (IAEA) mission
- 1995 – IAEA mission focused on the Safety issues area

1996 – ASSET (IAEA) mission
1996 – "Insurance" (March & McLeuman, Gradmann & Holler)
1997 – "Insurance" (Czech Nuclear Pool)
1997 – Peer Review (WANO, INPO)
1998 – IPERS (IAEA - PSA-1)
1999 – WPR, Follow-up (WANO), Verification of fulfillment of the WPR conclusion from 1997
2000 – "Insurance" (Czech Nuclear Pool), Continuous inspection on insurance risks
2001 – ISO 14000 (Det Norske Veritas), Certification audit of Dukovany NPP environmental impact
2001 – OSART (IAEA) mission, Operational safety verification
2002 – ISO 14001 (Det Norske Veritas) Re-certification audit of Dukovany NPP environmental impact

Course of program

The Equipment Renovation Program, called MORAVA, linked up to the modernization activities designed and implemented in the frame of the Back-fitting Program.

The Equipment Renovation Program documentation was approved during the ČEZ-Dukovany NPP technical council meeting in March 1998. The program was later named MORAVA.

Significance and purpose of the work on the Equipment renovation program have two main aspects – safety and economical (in summary – to reach the safety level accepted in the EU, to extend the license till 2025 while conserving the competitiveness).

Many safety relevant activities were already carried out. More than one half of the proposed measures (see Appendix 2) based on IAEA safety findings, which were assessed also in the frame of the EU (Atomic Question Group), are already resolved. All this induced a significant decrease of the probability of core meltdown (see Appendix 7). A concerted effort of the Czech Republic, Slovak Republic and Hungary helped to resolve common recommendation of the AQG for the VBK (see Appendix 4).

In the present time the main effort is directed to the solution of the Category III safety findings (the highest priority given for VVER440/213) and the intermediate category II.

Renovation of the Instrumentation and Control (I&C) system, designed in the seventies, is one of the most significant activities within the MORAVA program (for more details see Appendix 1). Thanks to preventive replacement of components and their design multiple backup, the I&C system reliability is sufficient. The renovation of the I&C system in the Dukovany NPP is performed stepwise without extension of outages duration. From the whole scope of activities, included in the I&C renovation, renovation in a part of the in-core measurement system is already carried out, and I&C renovation in diesel generators (reserve power supplies for NPP own consumption) is in progress.

Dukovany NPP Equipment renovation program control

Dukovany NPP Equipment renovation is composed of a set of partial constructions or modules. The part A – thesis specifying, among other things, the Dukovany NPP approach in the area of the Equipment renovation program preparation and implementation, was also part of the Equipment renovation program documentation (dated March 1998). Stepwise implementation of the individual Equipment renovation program parts or modules using standard procedure in accordance with the Dukovany NPP legislation in a way not to influence the refueling outages duration and not to modify the basic safety philosophy of the project was one of the basic principles. The selected way of project implementation has proven to be the most suitable also regarding the optimal use of financial resources of ČEZ, a. s. without the necessity to plan great yearly peaks.

Completion of the modernization activities of the Dukovany NPP Equipment renovation program (MOP) is scheduled for 2010.

The whole set of activities was assessed as to feasibility, including the complex economic analysis. The evaluation results confirm the correctness of the selected approach.

CONCLUSION

The Dukovany NPP represents cheap, reliable, and highly safe and environmentally friendly source of electric power in the Czech Republic. It is a Czech nuclear power plant as its design was completed in the Czech Republic, and it was constructed and manufactured there based on design background from the former Soviet Union. The parameters of the Dukovany NPP are fully comparable with the nuclear power plants operated in the Western countries (including the European Union countries) and will be further improved during the further plant development. It is also fully comparable with nuclear power plants operated in the countries in Western Europe as to safety; and is fully competitive as to economic effectiveness.

The conclusions of the WENRA evaluation report "Nuclear safety in the EC candidate countries" (10/2000) states: "It is expected that upon the complete implementation of the modernization program, the Dukovany NPP will reach the safety level fully comparable with the nuclear power plants of the same operational age operated in Western Europe".

The last evaluation of the European Union conducted at the beginning of 2001 by the AQG (Atomic Question Group) and the WPNS (Working Party on Nuclear Safety) shows that the major safety deviations, which they had indicated, are correctly identified and solved in MOP with the highest priority (see Appendix 1). The conclusions of the OSART mission carried out at the end of 2001 confirmed high safety level.

The Equipment renovation program MORAVA as well as its modernization part were thus determined to be in accordance with the European safety practice, and the preparation and implementation is advancing in a correct, controlled direction.

MORAVA program – scheduled part of the modernization until 2010

<p>Modification of equipment in PoE + 14,7m Replacement of electric motor drives of important valves Restraints against surging medium and flying objects Emergency aftercooling</p> <p>Instrumentation and control system renovation</p> <p>Spent fuel intermediate storage facility extension (MSVP)</p> <p>Change in the 110 kV reserve power supply connection</p> <p>Technical and Support Center</p> <p>Activities resulting from the leakage before break project Increase of KO resistance against vibrations Circulation pipe whip restraints</p> <p>Main and emergency control rooms habitability securing - ventilation systems</p> <p>Diagnostic systems – modernization</p>	<p>Completion in 2005 Completion in 2005 Completion in 2008</p> <p>M 1. Safety systems - 2010 M 2. Process computer systems - 2010</p> <p>Completion of the civil part in 2006</p> <p>Completion in 2005</p> <p>1. Part – 2005 2. Part – 2006</p> <p>Completion in 2005 Completion in 2006</p> <p>Completion in 2006</p> <p>Completion in 2006</p>
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