

## NUSIM 2000

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### COMPLETION OF MOCHOVCE 1&2 NUCLEAR POWER PLANT PROJECT

Commissioning of the Mochovce Nuclear Power Plant unit 2 fully completed the Mochovce unit 1&2 project. The power plant construction passed through a complicated evolution since early 80's. The genesis started with the change of the plant location due to a seismic resistance requirement raised by the former Czechoslovak Atomic Energy Commission, change of the design and contractor of the Instrumentation & Control system in early 90's, halt of construction in 1993 till 1996 due to a lack of funding, as well as a series of international reviews of safety aspects. All the obstacles had been overcome in the end, and completion works were re-started in 1996.

Looking back to the unit 1&2 completion project, I would like to highlight some aspects of the project, particularly the level of safety, technical and organisational conditions, and terms of funding.

The most important argument for completion of the plant was that VVER 440/213 reactor units were distinguished with very high level of passive safety, even overcoming Western-type PWR's in some aspects. The replacement of the original I&C system was another important contribution to the initial level of safety.

International safety reviews performed at Mochovce NPP between 1990 and 1995 (SIEMENS, EdF, IAEA, RISKAUDIT) confirmed the high level of safety of VVER 440/213 reactors, however, pointed out at some safety issues which had not been dealt with in the design. Those included e.g. the "external risks", primary-to-secondary leaks, qualification of pressurizer safety valves, and others.

It is necessary to stress that the Safety Improvement Programme defined for Mochovce NPP to comply with international standards did not become the most important part of the completion project due to external pressures, but based on natural requirements on nuclear power plant safety level generally accepted in 90's. The good example could be the seismic resistance of the plant which, though designed as seismic resistant in 80's, did not meet recommendations of IAEA Safety Guides issued in 1990 and therefore the seismic resistance had to be reassessed.

The base-line of the Programme was set by conclusions of IAEA and RISKAUDIT Missions. The Programme addressed all safety areas of Mochovce NPP resulting from the conclusions. The Safety Improvement Programme also included updating of some safety-related components due to the technical obsolescence; new diagnostic systems were installed to monitor integrity of safety components, and an emergency control centre was established for the needs of emergency planning.

The most important result of the Programme - which is applicable not only to Mochovce but all plants of the VVER 440/213 type - is that the containment with the passive bubble-condenser system has turned out to be fully functional and its acceptance in terms of safety has been confirmed.

The Safety Improvement Programme results were re-assessed by IAEA in 1998 and RISKAUDIT in 1998 and 1999 with positive results. Especially satisfactory is the conclusion of RISKAUDIT review performed as the PHARE project that is accepted by the European Union, saying: "Mochovce Nuclear Power Plant is the first Soviet-design nuclear power plant completed in an East European country that achieved a safety level comparable with western standards."

In addition to the Safety Improvement Programme the completion of the units 1&2 was complicated by other factors, too. Disintegration of the contractors after the construction had been halted, status of technological components after a long-term preservation, involvement of foreign contractors in new social and economic conditions, extensive design modifications - all those were risks that threatened the real commissioning schedule of the both units.

The question of technical status of plant components was another important factor in decision-making about the completion project feasibility. In 1993, EdF made the first status assessment of the main components. A detailed assessment confirmed the good status, a detailed programme of revisions and repairs of all components was developed prior to the start of completion works.

Contractual negotiations about the units 1&2 completion started in October 1995 with the general contractor of the electric and mechanical part SKODA Prague, civil works contractor HYDROSTAV Bratislava, general designer ENERGOPROJEKT Prague, assumed largest contractor for the safety improvements the French-German consortium EUCOM (FRAMATOME/SIEMENS) and the Russian ATOMENERGOEXPORT covering Russian organisations involved in delivery of some components, designing and engineering services. Addenda to contracts of the original contractors and contracts with the new contractors had to consider new conditions of the construction with respect to maintaining guarantees for the works implemented by 1995, as well as the involvement of EUCOM with extensive responsibilities in designing, delivery and assembly of new components. Naturally, this fact caused most difficulties during the

negotiations. Mochovce NPP and VUJE specialists developed Technical Specifications of Safety Measures for every single safety improvement clearly defining technical requirements. Despite of that, there were complicated links influencing activities of many other organisations. A contractual schedule of submitting input and output data of all organisations involved had to be developed. The schedule was consequentially linked to the unit 1 commissioning schedule. The number of contractor workers during the completion works peaked prior to the start of hydraulic testing in 1998 when there were about 4300 workers on the site.

Another important precondition of the project management was the development of the quality assurance procedures for the completion and commissioning process. The required quality of the construction management could only be achieved through a clear definition of relations and responsibilities of the organisations involved. Large assistance in this area was provided by EdF team.

In 80's, when the power plant organisation was being built up, it was assumed that the construction would resemble the Dukovany project and that it would proceed in a routine way. Therefore organisation changes were necessary to strengthen engineering activities, particularly in the process of the safety improvement implementation.

The plant personnel was trained in parallel with the construction completion and commissioning. Though most of the staff had passed through a training at Bohunice NPP acquiring good operating experience, the extensive modifications and the differences between the two Slovak N-plants in I&C required both new theoretical and practical training. Commissioning of the full-scope simulator in 1997 was the basic precondition of the operating staff preparation.

The commissioning process did not bring any revolutionary news from the technical point of view. Experience and verified procedures from commissioning of Bohunice and Dukovany NPP's were used under the direct leadership of the „Scientific Management of Commissioning“. The most significant results of testing turned out to be the containment tightness tests of the both units which brought historically best results among all NPP's of this type (about 2 % leak) proving the excellent quality of the construction. Of course, the commissioning process of a nuclear power plant is very complicated and demanding for all involved participants. In case of Mochovce it was even more complicated by implementation of safety measures done in parallel with the commissioning activities.

Another crucial aspect of the construction completion is the funding. The manner of funding of the Mochovce unit 1&2 completion, approved in September 1995, was based on loans with Governmental guarantees provided. Out of the total amount of 27.3 billion Sk, some 36 % has been provided by Slovak banks, 32 % by Czech banks, and 32 % by other foreign loans (coming from France, Germany and Russia). Contractual negotiations preceding the conclusion of loan agreements were also very complicated. The loan agreements were concluded on the 30<sup>th</sup> May 1996. The funding model approved by the Slovak Government assumed some other aspects enabling a problem-free repayment of the loans by SE. Those included e.g. restructuring of the IRB loan, tax allowances and yearly increase of electricity rates by 2 % above the inflation level. Unfortunately, the latter two conditions had not been fulfilled and financial sources that should have been flowing to SE budget had to be compensated by other loans having a direct influence on increase of the construction financial costs.

According to the re-assessed budget as of September 1999, the total costs of Mochovce units 1&2 (including deliveries implemented by 1995) amounted to 55.9 billion Sk. In comparison with the original budget set out in 1995, it means a rise by 7.7 billion Sk. About one half of the rise was caused by a drop of the Slovak currency exchange rate and rise of loan interests. Another half was caused by the fact that in 1995 the costs of the safety measures implementation could not have been specified exactly. The costs of technical solutions which were unknown at that time could have only been set as the best estimate.

The Mochovce unit 1&2 completion was the first project in Slovakia for which Environmental impact assessment study was developed. It was independently done by AEA Technology, U.K. The project was submitted to the public for comments at the break of 1994 and 1995. This helped significantly in making the nuclear power popular in Slovakia. The atmosphere of the unit 1 commissioning was excited enough, sometimes having undesirable influences, though the public opinion polls showed that it was acceptable for the most of the Slovak public. A part of the Slovak public expressed disagreement with operation of the nuclear power plants, however, attempts to make it a political issue was derogatory. As the Austrians did everything to stop the commissioning process, including presence of the Austrian team of experts at Mochovce - requiring a week-long interruption of the physical commissioning, created a complicated work atmosphere and uselessly stressed all the power plant staff.

In the end, I would like to give thanks to all those who provided their brains and efforts for the successful completion of the plant. The importance of this achievement has spread out far behind the Slovakian borders. The Mochovce personnel is ready to prove - through an effective, reliable, and safe electricity generation - that this plant will be a benefit for the whole country.