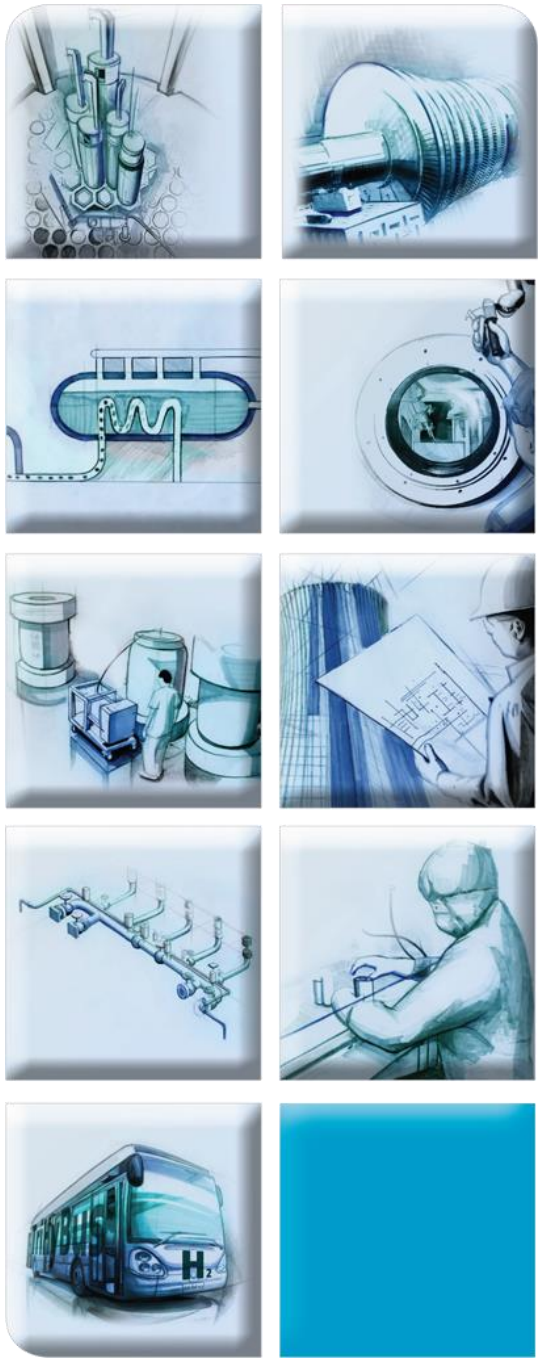

ÚJV Řež, a. s.

Experience with power uprates of the nuclear units with VVER 440 and VVER 1000 reactors

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Basic principles

The “Thermal Power Uprates (TPU) of the Nuclear Power Plant`s (NPP) Dukovany with VVER 440/213 reactor and Temelin with VVER 1000/320 reactor by Project Reserves Utilisation” projects are based primarily upon utilisation of output and capacity reserves of the NPP`s facilities, in particular the primary circuit.

In both projects they have been taken into account yet been realized, but the planned modernization of some equipment secondary circuit including the electrical part of nuclear units.

Thermal power increasing has been achieved by the active core power increasing and the primary and secondary circuits parameters adjusting.

Basic principles

Power increasing of individual units was achieved by utilisation of project reserves, and, if the analyses proved it to be necessary, also by modification of systems and components while the acceptable safety margins (reserves) maintained. Key equipment project reserves was drawn only up to a level at which sufficient safety margins were maintained. During the realization we respected the requirements to preserve the project`s life of those primary and secondary circuit components which are impossible or difficult to exchange. The possibility to prolong the NPP`s operations over 40 years have been maintained.

Purpose

- The main reason to implement this project was to have higher electrical energy production which requires an acceptable increase in yearly operational costs and low investment costs, i.e. the economic advantage of the project.
- 1. step: Preliminary study – Key equipment project reserves may be drawn only up to a level at which sufficient safety reserves are maintained
- 2. step: preliminary evaluation of the primary circuit technology equipment reserves as part of pre-project preparations, which also included an evaluation of the secondary circuit and electrical part and an evaluation of environmental impacts with respect to the water system, microclimate and radioactive releases for power to 109% Nnom (EDU) and 108% Nnom (ETE).

Increase of power

- Based upon a technical/economical comparison of the variants available, increasing the nominal thermal power of the NPP Dukovany units to 1444 MWt (increase to 105% of the current value) and Temelin units to 3120 MWt was selected (increase to 104% of the current value)

Comparison of powers units VVER 440

Country	NPP - Reactor	Model	Capacity (MW)			%
			Thermal	Gross	Net	
Czech Rep.	Dukovany-1	VVER V-213	1444	500	468	105
	Dukovany-2	VVER V-213	1444	500	471	105
	Dukovany-3	VVER V-213	1444	500	468	105
	Dukovany-4	VVER V-213	1444	500	471	105
Finland	Loviisa-1	VVER V-213	1500	520	496	109
	Loviisa-2	VVER V-213	1500	520	496	109
Hungary	Paks-1	VVER V-213	1485	500	470	108
	Paks-2	VVER V-213	1485	500	473	108
	Paks-3	VVER V-213	1485	500	473	108
	Paks-4	VVER V-213	1485	500	473	108
Russia	Kola-1	VVER V-320	1375	440	411	100
	Kola-2	VVER V-320	1375	440	411	100
	Kola-3	VVER V-213	1375	440	411	100
	Kola-4	VVER V-213	1375	440	411	100
Slovakia	Bohunice-3	VVER V-213	1471	505	471	107
	Bohunice-4	VVER V-213	1471	505	471	107
	Mochovce-1	VVER V-213	1471	470	436	107
	Mochovce-2	VVER V-213	1471	470	436	107

IAEA: REFERENCE DATA SERIES No. 2 Nuclear Power Reactors in the World, 2015 Edition

NPP Dukovany – 105%

- There is no problem with increased primary circuit thermal power up to 110% according to foreign experience
- Restrictions on the NPP Dukovany are mainly due to the requirement for the operator to minimize the impact to critical technology components
- The higher efficiency of the NPP Dukovany is evident if we compare it to the NPP Paks and Bohunice. The NPP Dukovany electric power is unchanged at lower primary circuit heat power.

Brief NPP Dukovany technical parameters

Reactor thermal power [%]	100%	105%
Reactor thermal power [MWt]	1375	1444
The hot loop pressure at the RPV outlet [Mpa, abs.]	12,66	12,66
The hot loop temperature at the RPV outlet [°C]	297 +/- 2	299,0
The cold loop temperature at the RPV input [°C]	267 +/- 2	268,4
The steam pressure in the main steam collector [Mpa, abs.]	4,71	4,71
Project nominal flow rate [m3/hour]	41000-45000	41500

Temelín NPP – 104%

The 104% N_{nom} power was selected with regard to:

- Use experience with an implementation of a similar project at the NPP Balakovo and the NPP Volgodonsk,
- Possibility to use fuel type TVSA-T,
- Possibility to implement the project using the existing TGs,
- No necessity to increase drainage authorized limits and raw water intake,
- No need for significant equipment modification.

Stručně technické parametry ETE

Reactor thermal power [%]	**100%**	**104%**
Reactor thermal power [MWt]	3000	**3120**
The hot loop pressure at the RPV outlet [Mpa, abs.]	15,73	**15,73**
The hot loop temperature at the RPV outlet [°C]	318,80	**320,30**
The cold loop pressure at the RPV input [Mpa, abs.]	16,18	**16,18**
The cold loop temperature at the RPV input [°C]	289,40	**290,00**
Total steam production in SG [kg/s]	1643,84	**1717,00**
The steam pressure in the main steam collector [Mpa, abs.]	6,10	**6,08**
Project nominal flow rate [m3/hour]	**88000**	**88000**

The UJV Rez proportion of on the NPPs power uprates

- Dukovany 105% (from 2005 to 2009, respectively. 2012 last block)
  - Supplier model: CEZ + 6 major suppliers (UJV Rez ensure supervision and safety analysis within the scope of Chapt. 4 and 15 Final Safety Report)

- NPP Temelín 104% (from 2010 to 2013, evaluation in 2014 after one year of operation on increased power)
  - Supplier model: CEZ + 2 main contractors (UJV Rez and TVEL) - UJV Rez worked as a general contractor and coordinator of the Czech organizations

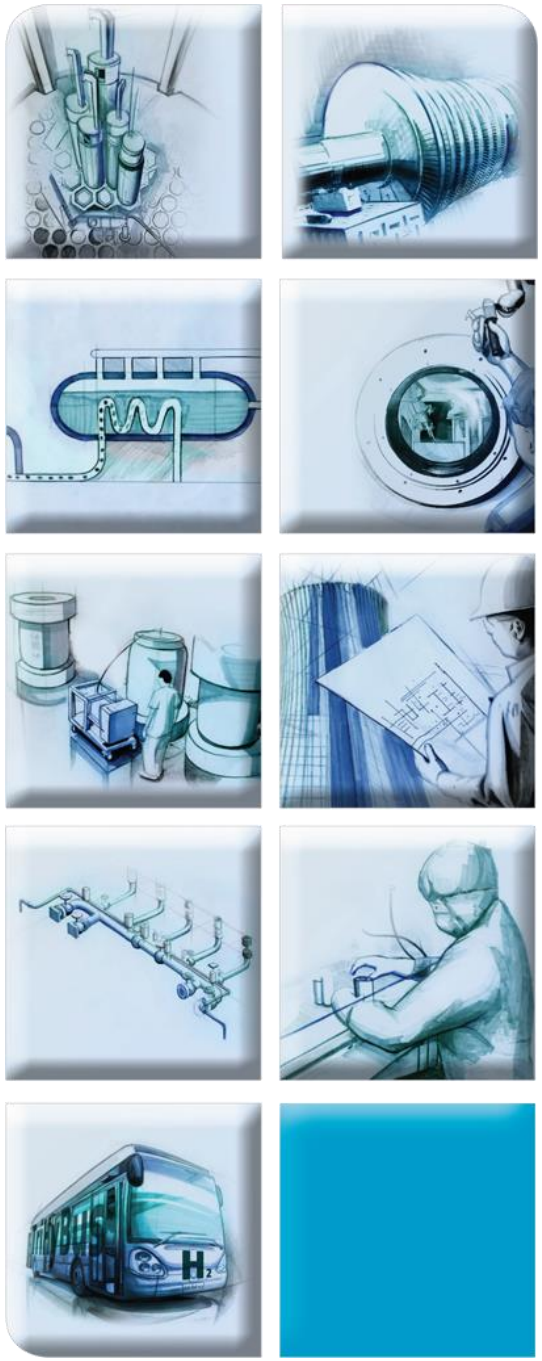
Conclusion

The project “Thermal Power Uprates (TPU) of the Temelin NPP” also contained one year "surveillance program of trial operation", which confirmed the accuracy of project solutions as no deviations from the Temelin NPP units’ nominal operation in the period under review were not directly caused by the project implementation to Power Uprates.

The operator gained an expected benefit from implementation of the NPPs Dukovany and Temelin power uprates projects.

Conclusion

- The UJV Rez participation in the TPU NPP Dukovany project and in management of the subsequent TPU NPP Temelin project proved that UJV Rez has sufficient expert capacity for complex solutions and managing of large projects for the needs of the Czech NPPs, but more, for both Czech and foreign NPPs with VVER reactors
- In realization of NPPs Dukovany and Temelin power uprates were involved more than 150 professionals from the UJV Rez
- Selected safety analyses were performed for 110% NPP Dukovany power and for 108% NPP Temelin power. All these analyses (for VVER 440 was also experience from abroad included) have confirmed additional potential for next possible safe power uprates increasing



Thank you for your attention.