



TEMELÍN POWER UPRATE

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TEMELÍN POWER UPRATE



TEMELÍN ... more efficient and powerful



Uprate of nom. reactor
thermal power:

3000 => 3120 MWt (+ 4%)

Electric Power:

1016 => 1056 MWe (*)

+ 40 MWe / unit =

+ 80 MWe total
=> +0,6 TWh/year

(*) exact values are dependent on external conditions

Cheapest and cleanest new power source ...

PROJECT MILESTONES



- **20.5.2010 – approved Project Intent**
- **09,10/2010 – contracts (NRI, TVEL)**
- **2010÷12 – analytical part of the uprate project**
- **Refueling outages 2011/12/13 – implementation of related equipment modifications**
- **2012÷13 – personnel training**
- **22.4.2013 – nuclear safety regulatory body (SÚJB) permission**
- **18.8.2013 – 3120 MWt on unit 2**
- **22.9.2013 – 3120 MWt on unit 1**

MAIN FEATURES ...



The Temelín Power Uprate project key features:

- **No change in:**
 - fuel design
 - technological safety system's design (flow rates, volumes, ...)
 - safety analysis acceptance criteria
 - SG secondary pressure

- **based on utilization of reserves existing in the current design
=> NO extensive modifications of plant equipment => unique
economical parameters**

- **repeated project (... already implemented on several russian VVER-1000
units prior to Temelín)**



FUEL & LICENSING

- Safety Analysis, SAR revision
- Update of methodologies for reload design and reload safety evaluation
- 1st 104% reload design

NORMAL / ABNORMAL OPERATION

- Analysis of operational modes (normal, abnormal, accidents), update of operational procedures
- Chemistry, radiation monitoring, ...

SYSTEMS & EQUIPMENT

- Strength, lifetime, EQ evaluations
- Related equipment modifications (incl. new I&C settings)

PROJECT SCOPE



ENVIRONMENTAL IMPACT

- Proof of no significant environmental impact (all limits remain valid)

PERSONNEL TRAINING

STARTUP TESTS

EQUIPMENT MODIFICATIONS



Areas of main equipment modifications

I&C

- **RPS** and **LS** settings
- Few **PCS** settings
- Field instrumentation: expansion of span of several sensors
- **NAPs / Beacon** settings

Technology

- Increase of hydraulic head of condensate pumps

Electric equipment

- Uprate of generator Sn (**1111 MVA => 1250 MVA**) supported by several adjustments to provide better cooling, new PQ diagram settings (see picture)
- Modification of generator breaker cooling system
- Several protection settings

EQUIPMENT MODIFICATIONS (2)



Generator ...

$S_n = 1250000$ kVA
 $P_n = 1125000$ kW
 $U_n = 24000$ V
 $\cos\varphi = 0.9$
 $f_n = 50$ Hz

Diagram je platný pro:

Max. tepl. sek. chladicí vody
(vstup do chladiče vody) [°C]

$t_{sv} = 33 \quad 33 \quad 33$

Max. tepl. sek. chladicí vody
(vstup do chladiče vodíku) [°C]

$t_{sv} = 33 \quad 33 \quad 33$

Max. tepl. prim. chladicí vody
(vstup do stat. vinutí) [°C]

$t_{pv} = 43 \quad 41 \quad 43$

Max. tepl. chladicího vodíku
(výstup z chladiče vodíku) [°C]

$t_{H2} = 47 \quad 44 \quad 47$

Tlak vodíku v [kPa] abs.

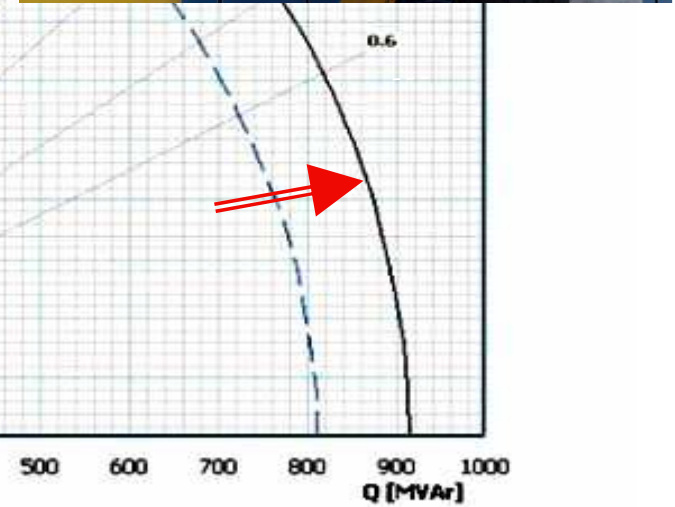
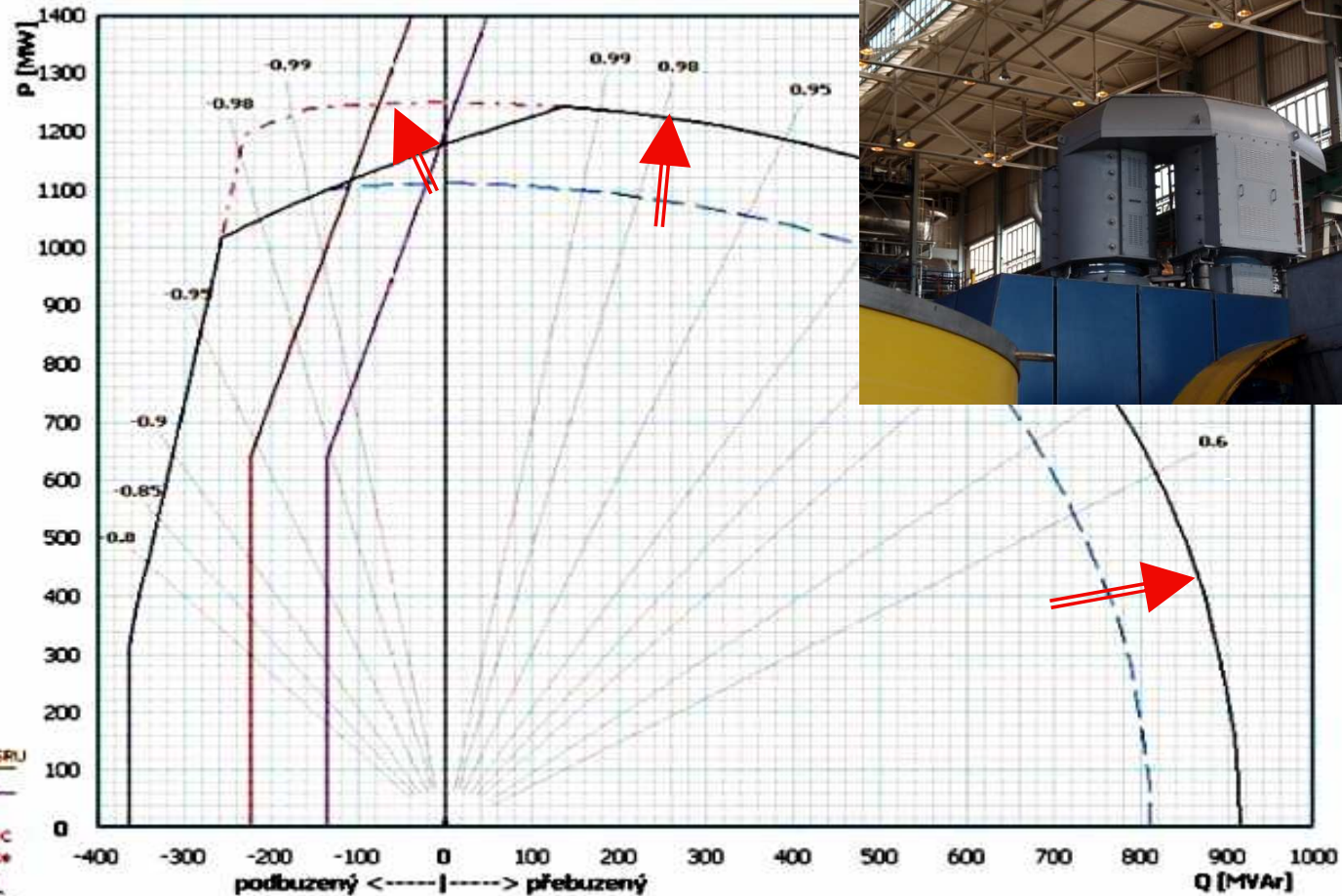
$P_{H2} = 600 \quad 600 \quad 600$

$U/U_n = 1.000 \quad 1.000 \quad 1.000$

$f/f_n = 1.000 \quad 1.000 \quad 1.000$

Styl čar: Přívodní HMP s ASRU
 Studie HMP

Očekávaná teplota stahovací desky 150°C (lokální), kde tolerance (odchylka) je +30°C, tj. max. teplota 180°C.
 Očekávaná teplota stahovací desky 170°C (lokální), kde tolerance (odchylka) je +35°C, tj. max. teplota 205°C.



STARTUP TESTS



3 startup stages: 0 => 96% => 98% => 100%

- Standard reactor physics tests, protection system calibrations
- Evaluation of main parameters incl. predictions ...
- Tests of electric equipment – parameters, heatup (generator, outputs conduits, unit transformer) ...
- Vibrations of main components, other diagnostics tests
- Abnormal process (dynamic) test (cond. pump trip)

STARTUP TESTS (2)



RESULTS ... =>>> O.K.

SAFE OPERATION ON UPRATED POWER CONFIRMED

- **All safety criteria met**
- **Small deviations not directly related to uprated power**
 - High temperature of encapsulated conduits below generator – inoptimal constructional configuration
 - Elevated temperature of generator retractive plate in operational states with very negative reactive power (underexcited)
 - Inability of completion of valid steam humidity measurement using chemical method (Na concentration) – alternate method employed

Project continues till 2014

=> Evaluation of complete fuel cycle operation on uprated power, evaluation of equipment inspections performed in 2014 refueling outages

QUESTIONS, REMARKS ...

