

2002

Slovenské elektrárne – NPP Bohunice

1984 – Unit 3 commission

1985 – Unit 4 commission

1997 – SE, a.s. approved „NPP V2 safety upgrading and improvement program“

Starting position:

1. CDF = 7,36 10⁻⁵/year
2. Two RTS redundancies
3. No RLS, no PAMS, no SPDS
4. Insufficient seismic reinforcement and others

75 safety identifiable problems

2004

All defined goals were met:

- scheduled time – finished to end of 2008
- Plan cost: 356 411 837,- Euro
- Actual cost: 351 207 396,- Euro
- implemented all 50 main upgrading tasks

Main contractors:
AREVA, ATOMSTROJEXPORT, SIEMENS Germany, SIEMENS Bratislava

SKODA Slovakia, PPA Energo Bratislava, VUJE Trnava, Termoprílad Ukraine

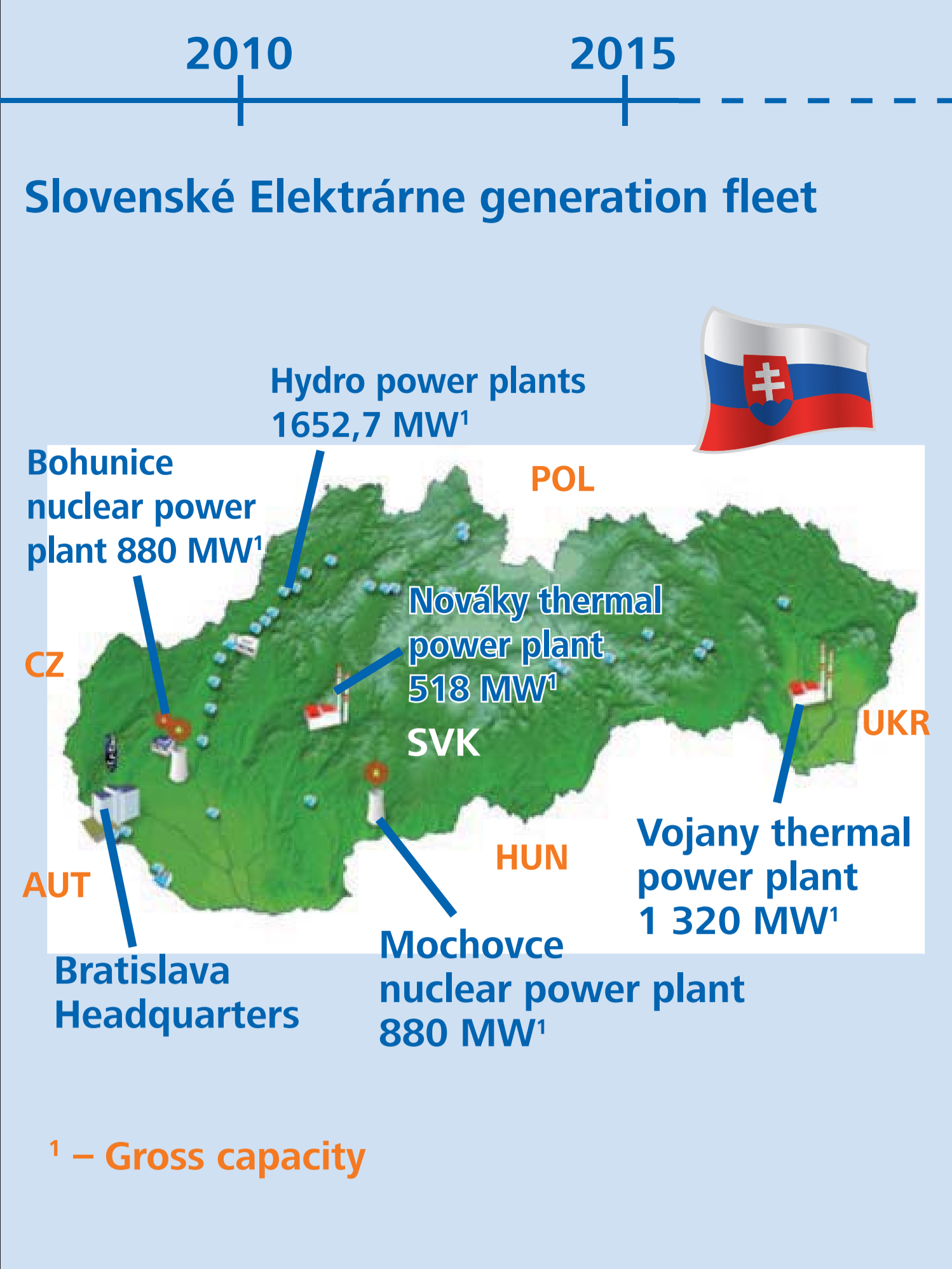
EMERSON ProCS, s.r.o., PHOTONIS France, YOKOGAWA Austria

MGPI France, PMA Germany, SCHNEIDER France

2008

Final position

1. CDF = 3,23 10⁻⁶/year
2. Three RTS redundancies
3. New RLS, PAMS, SPDS
4. Seismic robustness structures, systems and components and solved old safety problems



Priorities of the modernisation program

To solve:

1. Generic problems and deviations, that were summarized in document IAEA-EBP-WWER-03 of 1996 - „Ranking of safety issues for NPPs of WWER 440/213“
2. Decisions of the Regulatory
3. Operator's requirements and experiences
4. Other requirements

Goals of NPP V2 modernization program:

- Safe operation of units and achievement of probability goals recommended by IAEA (INSAG-3) for operated NPP
- Reliable, safe, ecological and efficient electricity and heat production
- Unit power upgrade, inclusion of units to primary and secondary regulation modes, extension of NPP V2 units life to 40 years at minimum

Basic works of the NPP V2 modernization program

Seismic equipment qualification

- New RHR system
- Replacement of essential service water system
- Replacement high and low pressure emergency feed water system
- New steam generator safety release valves to atmosphere
- Seismic reinforcement of the all equipment and structures needed for reactor shutdown, cooling and remaining in cooled status

Replacement superemergency feed water system

- extended from two to three redundancy
- new feedwater pipelines to blowdown of all SG

Closed classification and qualification equipment

Electrical systems

Ultimate separation safety and non-safety electrical cabinets, distributors, control voltages and interlocks

Replacement of the:

- DG control and protection system
- 0.4kV distributors of 2nd emergency supply category
- 1st emergency supply category and 6kV switchers
- Hermetic electro - penetrations
- Power system of the MCR and ECR
- Interlocks of reactor and primary side systems

I&C

Ultimate separation all redundancies – no common impulse lines, sensors, cabling, cabinets, spaces

Ultimate separation safety and non safety part of MCR and ECR (new safety panels in MCR and ECR)

Replacement of the:

- RPS (RTS and ESFAS – 3 redundancies, each obtains of 2 diversities with 3 channels)
- Ex-core neutron flux monitoring system
- RCS
- Qualified supply disconnectors for control rod drives
- Unit computer information system

Installation new systems: RLS, PAMS, SPDS



The Design fundamental of NPP V2 modernization program:

1998 to 2000, VÚJE - Trnava elaborated the document: „Safety concept for safety upgrading and improvement for NPP V2“, The Safety concept determine:

- tasks
- measure
- priorities
- realisation schedule
- QA for all modernisation project

For all concerned tasks was elaborated:

- safety evaluation – deterministic, PSA
- economic evaluation
- requirements – technical, qualification, environmental, relation to I&C, electrical power, interlocks, MCR, ECR, etc.

One chapter of the safety concept solved of the power uprate problems

The Power up rate (from 2004 to 2010)

April 2005 - EIA
April 2005 – SE took decision to start power uprate program
April 2006 - Design analysis of VUJE
Architect of the design Power uprate is ÚJV Řež
Basic steps of power uprate proces:

a) **Achievement of design electric power of Unit (440 MWe) from 425 MWe) by improving the efficiency of the thermal cycle (2006 – 2008):**

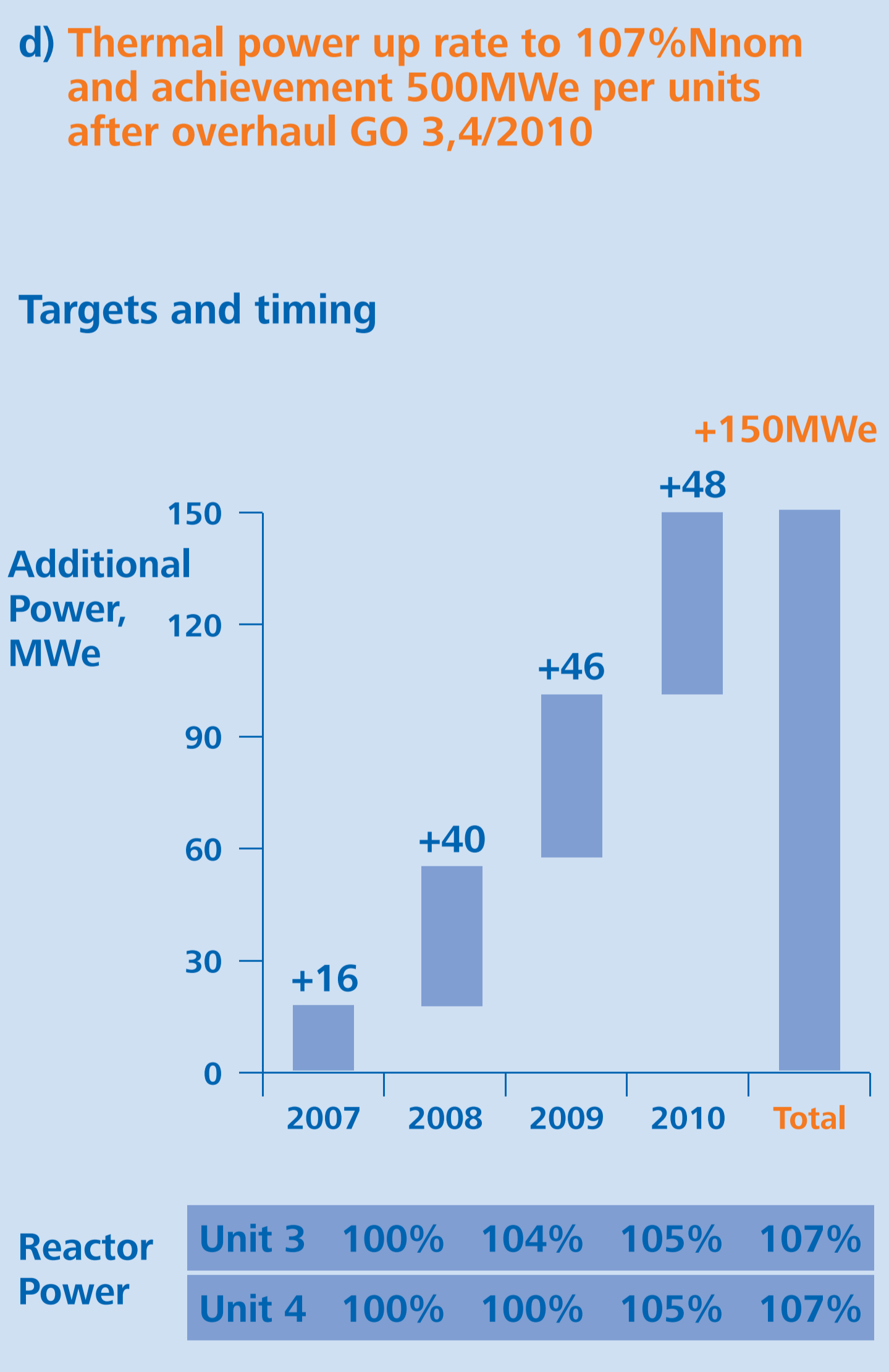
- By changing the disposition and increasing the number of tubes in the turbine main condensers
- By modifying the cooling towers
- By reducing the steam pressure losses in steam pipelines between SG and TG - replacement of measuring throats and moisture separators

b) **Thermal power up rate to:**

- 104 % Nnom on Unit 3 in 2008
- 105 % Nnom on Unit 4 in 2009

c) **Further improvement of thermal cycle efficiency (2008 – 2010):**

- replacement of the new Turbines and Bypass to main condensators
- replacement of the new electric Generators
- replacement new units Transformers 400kV
- Replacement of hydraulic control systems of TG
- Modification of power outlet from G 32
- The implementation of the Reactor thermal etalon



General designer of the NPP V2 modernization program was VÚJE Trnava

Total scope: 50 main upgrading tasks

General Designer elaborates:

- design
- safety evaluation
- quality assurance program
- operational documentation

Slovenské Elektrárne acts as a General Contractor

Implementation of NPP V2 modernization program was scheduled during 2002 ÷ 2008 years

A large number of suppliers was managed and coordinated also in connection with planned outages (peak presence: 1250 external workers)

New fan systems and air condition for MCR, ECR, I&C and electrical safety rooms

Fire protection

- „Separation of fire sections based on the fire protection project“, installation of new fire doors and covers with 90-minute fire resistance
- „Control of selected fire dampers“ – new fire dampers were replaced in all HVAC air ducts with remote control by fire detection system CERBERUS
- Spraying of steel structures in the turbine hall
- „Fire retardant cable spray“ with fire duration exceeding 90 minutes
- Installation of stable fire extinguishing equipment in RAW storage and Main room of the circulation pumps

Internal risks caused by high-energy piping rupture

- Installation of swing limiters on steam and feedwater penetrations, on main steam header piping on +14.7m
- Additional reinforcement of steam and feedwater pipings in the containment
- Reinforcement primary pipelines from diameter 120 mm

MCR and ECR filtrating and fan system

NPP V2 was equipped with system with filtrating units. System is 100% backed up with aerosol and iodine filters and it's capable of over-pressure establishment in MCR

Containment hydrogen concentration monitoring system

- System is located into containment, no pipe line and air blowers, only sensors and cabling
- Sensors are qualified for environment parameters of the severe accident.

Measurement of the water level and pressure in containment

Operator's requirements

Operator's requirements implemented during of the NPP V2 modernization program - Unit power upgrade, inclusion of units to primary and secondary regulation modes, extension of NPP V2 units life to 40 years at minimum:

- replacement of the new Generators exciter
- Replacement of the electrical units protection
- Replacement of the unit 400kV breakers
- implemented III. off-site power supply NPP V2 for emergency electric power supply
- replacement of the insulated conductors
- replacement of the primary circuit control systems

Severe accident management (2009 – 2013)

Implementation of Safety Upgrading Measures in Operational Units of Bohunice V-2 in the Area of Mitigation of Severe Accidents:

- Controlled depressurization of RCS during severe accident
- installation of recombiners and igniters
- Vacuum breaker
- Establishing circulation channel for coolant along the reactor pressure vessel wall
- External sources of coolant
- Dedicated diesel-generator
- Monitoring of parameters needed for accident management

Innovation of I&C and electro operational systems of NPP V2 (2010 – 2017)

Gradual substitution of I&C and electro with application of the new structures of digital systems with I&C functions completion and hybrid non safety systems MCR and ECR with „soft-control“

Plant Life Management program for Safe Long Term operations units at NPP Bohunice V2 2009 – 2045

New gadolinium Gd-2 fuel (2006 – 2014)