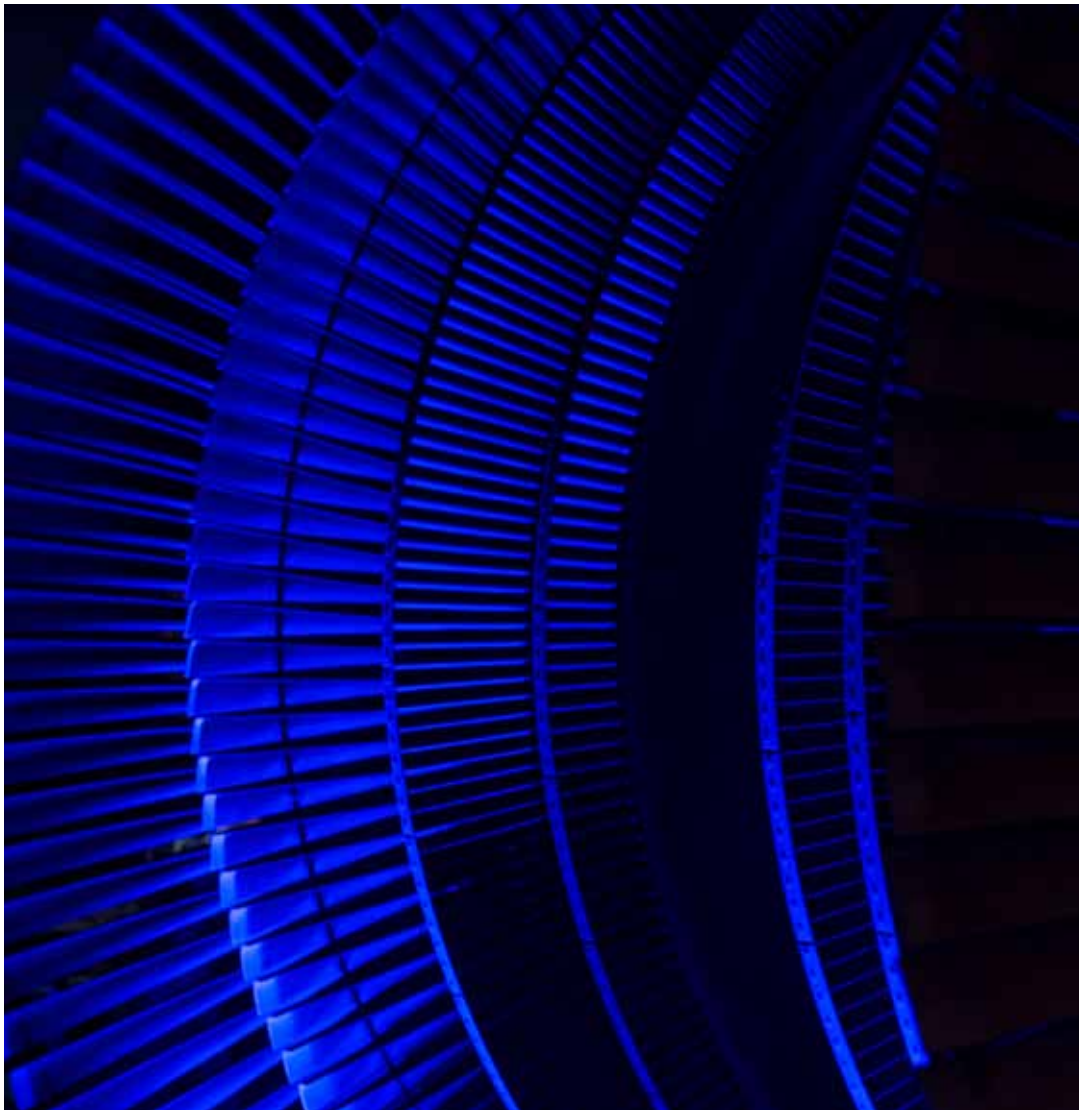
General overhauls 2013

Mochovce NPP Units 1 and 2



SLOVENSKÉ ELEKTRÁRNE

Enel

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Index

2013 in numbers

Number of reactor scrams

0

Event INES 1 and higher

0

Installed power

471

MWe/unit

UCF Unit 1

93.33

UCF Unit 2

94.23

Collective effective dose

150

man mSv

Electricity production

7.64

TWh

Electricity supplies

7.11

TWh

CO_2 emissions savings *

7.5

million tons

GO duration Unit 1

23.55

days

GO duration Unit 2

20.00

days

Number of employees

1,429

employees

* compared with thermal power plant firing black coal

Main GO activities

Unit 1

- Refuelling
- External non-destructive test of the reactor pressure vessel
- General overhaul (GO) of the reactor coolant pump (RCP) 1, 5 and GO of RCP 1, 4, 5
- Non-destructive tests of steam generator (SG) 5
- Non-destructive test of bubble condenser trays 7, 8, 9 and painting of tray 10
- Maintenance works on the main emergency core cooling system (ECCS) 3, essential service cooling water (ESCW), electric part
- Maintenance works on the main steam header (MSH) 1, 3, 5, GO of the fast closing valves (FCV) Rockwell 1LBA61,63AA007
- GO of electric feedwater pump (EFWP) 1 and EFWP 4, 5 electric drives
- GO of diesel generator (DG) 3, standard repairs of DG 1 and 2
- GO of generator 1MKZ01
- GO of HP part TG12
- GO of circulating cooling water 3

Unit 2

- Refuelling
- GO of RCP 4 and electric drives of RCP 1, 4
- NDT SG 4
- Non-destructive tests of bubble condenser trays 4, 5, 6 and painting of the tray 11
- Maintenance works on the main emergency core cooling system (ECCS) 2, essential service cooling water (ESCW), electric part
- Maintenance works on MSH 2, 4, 6, GO of SG safety valves – 2LBA62,66AA002,3, GO of FCV – 2LBA62,66AA006
- GO of electric feedwater pump (EFWP) 5 and EFWP 2, 5 electric drives
- GO of diesel generator (DG) 5, standard repairs of DG 4 and 6
- GO of generator 1MKZ01
- GO of HP part TG21
- GO of circulating cooling water 2

Safety

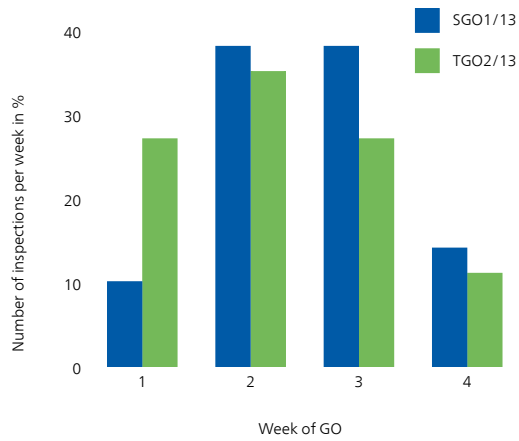
In order to increase the safety in the nuclear power plant, the main plant safety messages were applied during the outage. The message "Each of us will take personal responsibility for safety!" became the main motto.

The goal of this message is to ensure safety and protection of employees by suitable coordination of activities and protective measures. Appointed documentation coordinator guarantees the design documentation coordination in the preparatory phase. During performance of tasks, the safety coordination passes to appointed safety coordinator.

Lowering of operational costs, improvement of work quality, decreasing of number of work accidents and occupational diseases are the basic requirements for proper coordination.

Considering high number of activities performed during an outage it is necessary to perform detailed analysis of risks and hazards in order to create a safe working environment.

It is performed already during the preparatory phase and includes assessment of risks of all activities performed during the outage. It defines the hazards of working environment, assesses expected risks and determines actions for their removal. Implementation of protective measures requires mutual cooperation among all involved parties.
Defects found during implementation of works are recorded in notifications including determination of correction actions for their removal. The following chart shows safety inspections during individual GO.



The above chart shows that most inspections take place during GO weeks 2 and 3. This is the period with majority of performed GO tasks. Scope of works during the first and the last weeks is affected by unit shutdown and start-up.

The main contribution of inspection activities is to meet the common goal of **"zero"** accidents and **"zero"** fires during GO.

Waste management during GO

Performance of works scheduled for GO in 2013 generated other and dangerous waste. Waste types and volumes were planned according to relevant investment projects or work orders.

The following waste volumes were generated during GO:

All waste was properly stored and continuously removed pursuant to valid legislation.

Municipal waste increase was recorded during GO. This fact is always affected by increase of workers working in the Mochovce locality in given periods.

GO	Other waste in kg	Dangerous waste in kg	Total in kg
TGO1/13	1,200	20	1,220
TOG2/13	23,418	729	24,147
Total in kg	**24,618**	**749**	**25,367**

Evaluation of the main outage goals

Indicator
Event with nuclear safety impact
Workers´ accident (SE / contractors)
Unplanned irradiation of workers
Contamination event with decontamination in the plant medical centre
Fire
Event caused by human factor
Fall of object to open primary circuit
Drawing of CED (manmSv) below the limit
Liquid RAW (m^3)
Solid RAW (kg)
Observance of the work schedule on critical path
Planned outage (days)
Number of work orders
Number of work orders added during performance of works
Number of outstanding work orders

	SGO1/13			TGO2/13	
Plan	Actual	Fulfilment	Plan	Actual	Fulfilment
0	1	Unfulfilled	0	3	Unfulfilled
0/0	1/0	Unfulfilled	0/0	0/0	Fulfilled
0	0	Fulfilled	0	0	Fulfilled
0	0	Fulfilled	0	0	Fulfilled
0	0	Fulfilled	0	0	Fulfilled
0	2	Unfulfilled	0	4	Unfulfilled
0	0	Fulfilled	0	0	Fulfilled
142+10%	141.3	Fulfilled	91.4+10%	87.13	Fulfilled
3.0	3.46	Unfulfilled	3.0	1.981	Fulfilled
3,400	3,070	Fulfilled	3,400	2,699	Fulfilled
0	10	Unfulfilled	0	27	Unfulfilled
25	23.55	Fulfilled	20	19.96	Fulfilled
	4,305			4,199	
	219			201	
	16			16	

Collective dose during GO

Unit 1

During SGO 1/13

- **Plan** **142.500 manmSv**
- **Actual** **141.349 manmSv**

	Name	Binding CED approved by plant management	Actual
	For standard works according to schedule	128manmSv+10%	134.333
	Of that: external reactor NDT inspections	15manmSv	14.017
IPR			
IPR EMO 34100	Min. RAW, sample extraction line from reactor	2.00 manmSv	1.691
IPR EMO 30100	Hydrogen recombiners	4.50 manmSv	3.636
IPR EMO 49100	Modification of emergency steam removal from the reactor shaft	2.00 manmSv	0.129
	Extraction and insertion of witness samples	3.00 manmSv	0.874
IPR EMO 47600	Reconstruction of RCP vibration monitoring system	1.00 manmSv	0.000
IPR EMO 366 00	Replacement of CCTV cameras	2.00 manmSv	0.675
Total		**142.5 manmSv+ 10%**	**141.349**

Unit 2

During TGO 2/13

- **Plan** **91.4 manmSv**
- **Actual** **87.13 manmSv**

	Name	Binding CED approved by plant management	Actual
	For standard works according to schedule	85 manmSv	83.61
IPR			
IPR EMO 30100	Hydrogen recombiners	4.50 manmSv	3.098
IPR EMO 49100	Modification of emergency steam removal from the reactor shaft	1.50 manmSv	0.054
	Dismantling of temporary thermocouple measurement	0.400 manmSv	0.368
Total		**91.4manmSv+10%**	**87.13**

Reconstruction of DGS automations and electric protections

Diesel generators play important safety function. They supply electric consumers in case of external power supply failure. The investment project aimed at reconstruction of automations and protections of diesel generators started in 2013. Original automation design of the diesel generator stations (DGS), start-up mode automations from the unit, DGS home consumption automations and DGS failure signalization is at the technology levels of the 80´s, obsolete, and spare parts are difficult to be provided in case of equipment failures.

The main goal of DGS automation and DG start-up mode automation reconstruction is to reach higher quality and reliability of the safety systems.

The reconstruction is done in six stages by individual diesel generators. The first stage started on 5 September 2013 with reconstruction of 2DG2. It included complete replacement of DG home consumption switchboards, start-up automation switchboard, home consumption automation switchboards, and installation of control and information system PLC Simatic S7. The reconstruction also included replacement of load shedding mode automation switchboards, automatic start-up at under-voltage consisting of replacement of relay system with process units BC 1703 ACP.

Another activity included in the reconstruction was establishment of the monitoring workplace for all six DGS used for monitoring and archiving of all input and output, analogue and discrete signals of all levels entering (or exiting) the technology automats. New numeric systems are capable of evaluating the failure before placing

the request for their activation; they enable on-line monitoring and verification of correct technology setting and identification of failure states.

Implementation of the complete reconstruction will substantially improve the work of shift operation personnel.

The reconstruction in 2013 included the system 2 on Unit 2 – 2DG2, and system 1 in Unit 1. During SGO 2/14, works on DG system 1 on Unit 2 will be finished. The complete reconstruction will be completed in 2016.

* SGO – medium-term general overhaul – once in 4 years.

Inspection of reactor pressure vessel

The reactor pressure vessel is the most monitored component of the NPP primary circuit from the safety point, because it contains the reactor core with nuclear fuel and is one of the barriers against fission products release to the environment. The reactor pressure vessel is stressed by high temperature, internal over-pressure and neutron flux; therefore, its manufacturing must guarantee its integrity throughout its lifetime. The pressure vessel integrity must be kept also during the most severe conditions occurring at possible activation of the emergency after-cooling system connected with so called high-pressure thermal shock (PTS).

The reactor pressure vessel design should resist such events with large safety margins. To reach this, the vessel material mustn't contain defects possibly affecting its integrity. Non-destructive testing (NDT) is one of the methods used for checking of the reactor vessel material conditions, without material damaging. This method is also called defectoscopy. Ultrasound testing is one of many suitable defectoscopy methods. Ultrasound enables reactor material testing through the wall thickness reaching locally up to 465mm. Austenitic steel liner, i.e., welded-on layer, is subject to eddy current testing. All accessible surfaces are also checked visually using the TV cameras.

We use sophisticated testing systems for reactor pressure vessel testing. These methods belong to the technical development top in given NDT field and their solution is often unique.

Mechanical part of the testing system is called manipulator. It is remotely controlled and its task is to transport the testing probes to exactly defined testing points. Electronic part of the testing system controls the manipulator and scans the data. Data are stored in server and are used for reviewing and evaluation by an analyst. This method guarantees data evaluation with minimal time delay after their scanning. Manipulator´s attendance, data scanning and evaluation workplace is located in safe distance from the manipulator, sometimes even out of the reactor building.

NDT processes used for inspection are subject to qualifications based on requirements of the Nuclear Regulatory Authority of the SR. The qualification is process used for systematic verification of required sensibility, reliability and accuracy of the testing system in real NPP conditions. The qualification process is technically highly demanding and can take up to several years in case of reactor testing processes.

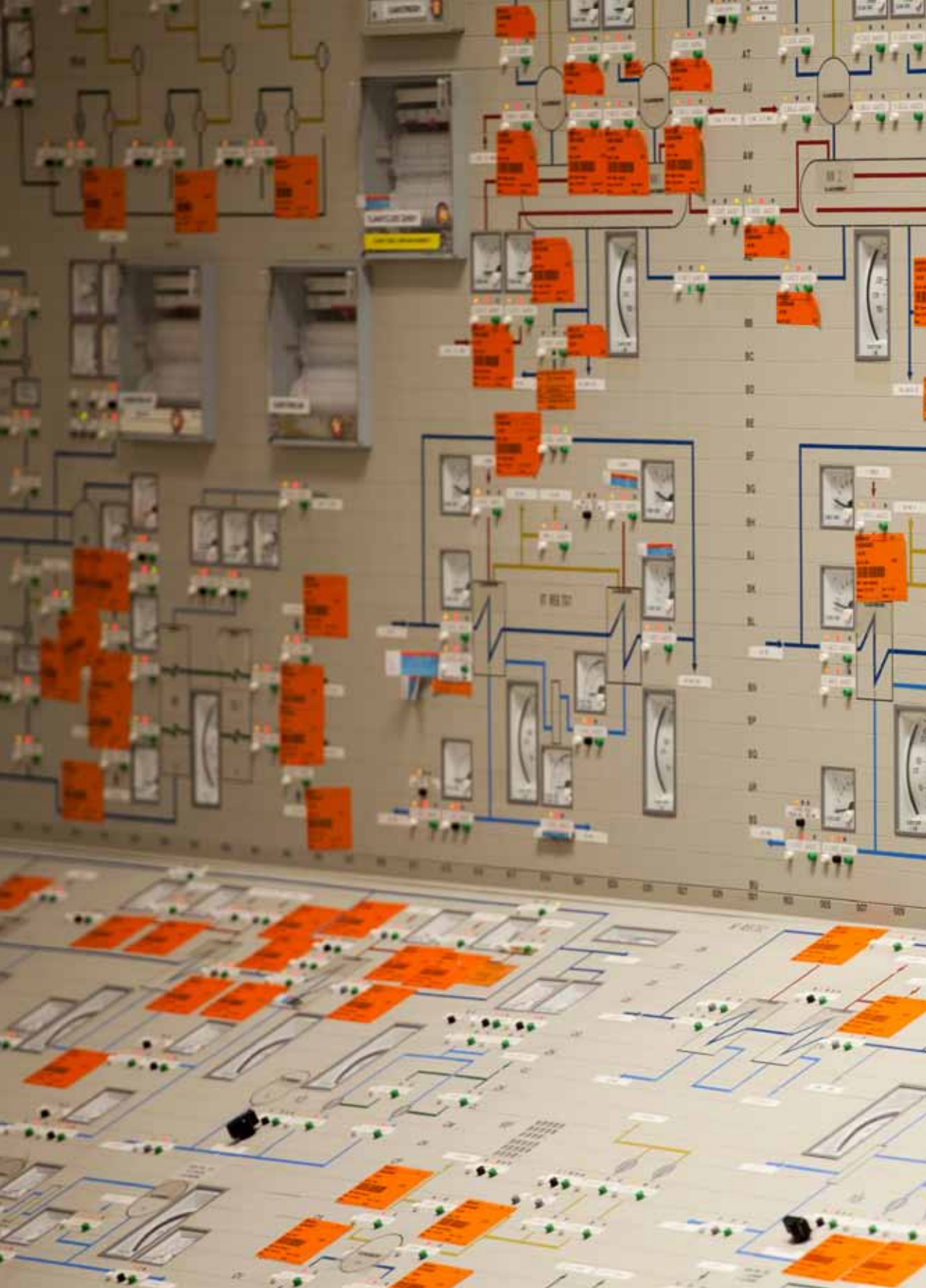
Personnel performing inspection is also subject to mandatory qualification. Besides standard qualification for NDT methods, the persons must be also qualified for attendance of specified testing system.

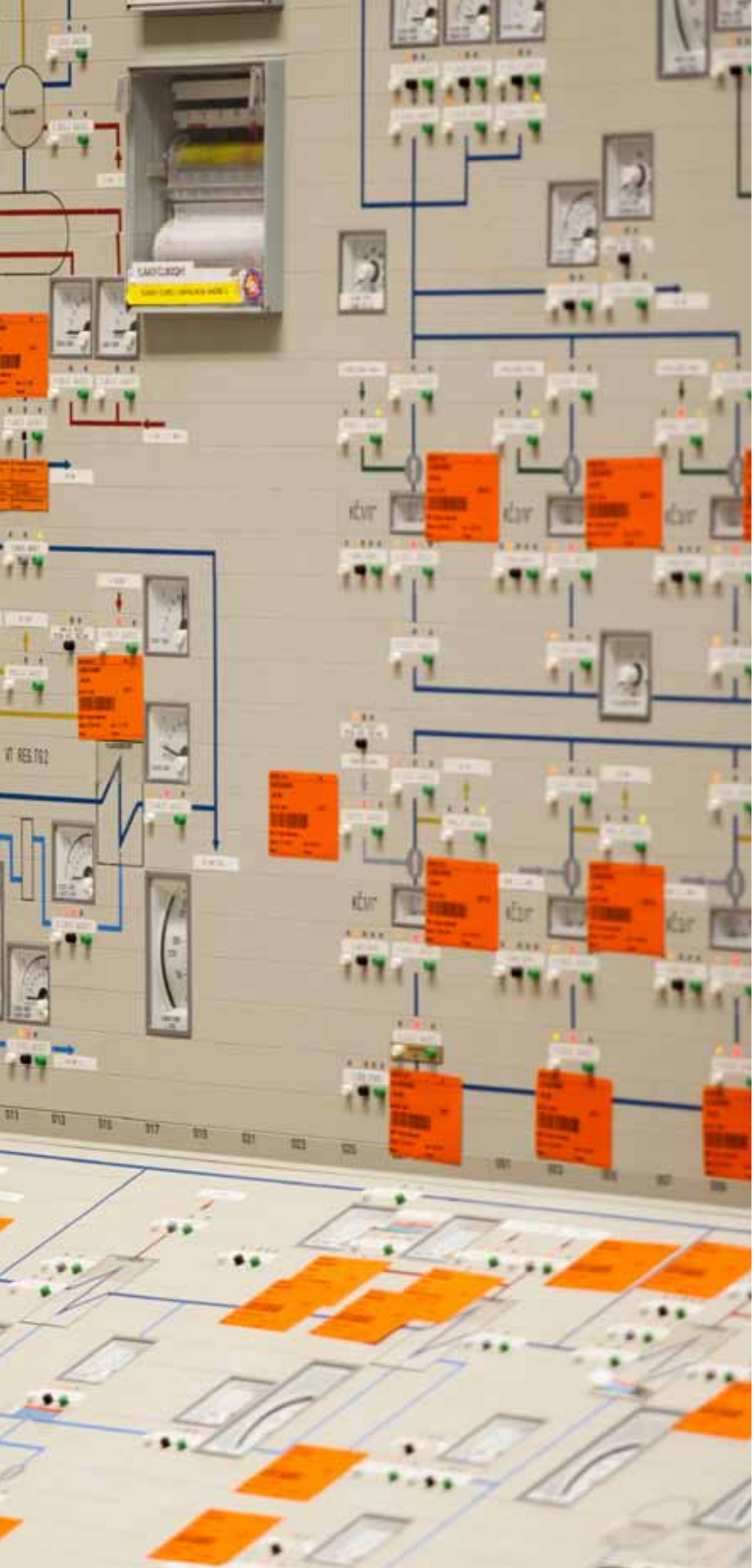
Pressure vessel of VVER reactor types can be checked from internal and external surfaces. Both inspections have the same main goals; differences are in scope of works that can be performed from given surface. The inspection is performed in regular 4-year intervals – alternating internal – external surface inspection.

External reactor pressure vessel inspection in Mochovce NPP Unit 1 was performed in 2013. In the past, this inspection was performed during extended general overhaul providing sufficient time reserve. Inspection of EMO Unit 1 in 2013 was specific, because it was done during the general overhaul, thus coming to the critical path. This fact has been known in sufficient advance, enabling us to optimize and qualify a new testing method resulting in significant time savings and timely performance of the inspection.

External reactor pressure vessel inspection uses manipulator USK 213. Large manipulator components – rotating platform, telescopic column and shielding are included in the original power plant design. Their task is to transport the ultrasound scanner to any point on the cylindrical part of the vessel. The ultrasound scanner checks reactor segments with size approx. 1m x 0.4m. The scanner was developed and manufactured by our workplace. Inspections of reactor pressure vessels performed by our department prove - with regard to defects frequency – satisfactory conditions of the reactor material. They are important inputs for permitting further operation of the reactors and extension of their lifetime.

Ultrasound scanner





Investment projects during GO

Delivery of two mobile power supply sources 400V AC

Mobile DGs with cable chasses will be used when none of three DGs supplying 6kV safety sections of the reactor unit is available. One DG is assumed for each unit. New mobile equipment enables power supply of pumps and fans for residual heat removal from the reactor core, charging of accumulators and power supply of power plant control systems in the emergency conditions. New equipment includes two independent mobile power sources for both power plant units. They will decrease the probability of residual heat removal failure from the core, thus significantly reducing the core damage frequency (CDF) values and large early radioactivity release frequency (LEFR) values monitored by NRA SR.

Complete reconstruction of refuelling machine electric part

Replacement of the fuelling machine control system, reconstruction and replacement of machinery parts. The project implementation started during unit operation in 2012 by replacement of the control system and machinery parts of the fuelling machine. Pre-complex tests were successfully passed before Unit 1 outage, followed by successful complex tests during Unit 1 outage. The project will continue in 2014 by implementation of Mast Sipping.

Replacement of servo drives on dump steam valves to atmosphere

New servo drives with moment end switches. Original thyristor blocks were replaced with control units AUMATIC. Control and signalization circuits were complemented with signal transducers performing signal modification for the control system BELT and valve position signal supply sources. The first replacement stage – 6 DSVA servo drives on one half-collector was performed during 1GO13 as enabled by the outage conditions. All servo drives will be replaced in four stages.

Replacement of ESCW valves and fans

Replacement of six original ESCW fans and electric drives with gearboxes for new fans with slow rotating electric drives without gearboxes and with frequency inverters on all three systems in Unit 1. New drives are attached to a new frame anchored to monolithic reinforced concrete foundation. Each fan has five settable blades. Their lifetime is 15 years.

Provision of proper cooling of unit 1 generator intermediate circuit coolers

The goal is to use self-cleaning filtrating equipment for smooth operation of generator intermediate circuit coolers without their shutdown due to cleaning of clogged filters and without any need for generator´s power decrease. The project includes installation of new self-cleaning filters to the cooler supply pipelines of generator intermediate circuit (one piece of TG11 and one for TG12). Filter cleaning process starts automatically after reaching the value $\Delta p = 30kPa$.

Modification of FFFE valves on external transformers

Replacement of 11 electric valves for new ones with electric drives of higher technical level ensuring flooding of dry channels in case of transformer fire. They work in automatic mode and are normally closed. They open upon arrival of "Fire" signal from the fire detection system subject to voltage-free status of relevant transformer. Firewater pumps start at the same time. Replacement is scheduled for relevant outages in 2012 – 2014 separately for units 1 and 2. Stage 3 was implemented in Unit 1 as part of SGO 1/13 – replacement of electric valves 1URA14AA053 and 1URA24AA051 on distributors of fixed firefighting equipment (FFFE) for external transformers 1BBT01 and 1BAT02. Replacement will result in higher reliability of new flap-type valves and higher efficiency of eventual fire extinguishing on external transformers.

Reconstruction of 0.4kV distribution switchboards – stage I

Current 0.4kV distribution switchboards of units 1 and 2 and their technical design face frequent failures. Removal of defects is difficult due to unavailability of spare parts and their price. Production of 0.4kV switches (ARV, J2UX) and relay automation transistors was terminated in 2000 and 2002.

The project goal is to guarantee operability of distribution switchboards by replacement of old components for new ones using digital automation; part of switchboards will be alternatively changed as whole (cabinets including protections). They include digital protections and automations including ASS (automatic stand-by start).

Replacement of tube cameras in Unit 2 containment CCTV

Replacement of old cameras with new CCD cameras include modification of connection of individual replaced cameras, addition of video signal encoders and video server to POSA system with data storage for continuous recording, and changes of internal connections of existing video central 2CYP2VU1 located in room A210/1 at +6.00m in SO 800/1-01.

Reconstruction of DGS automations – 2DG2 system 2

Overall reconstruction of existing DGS automations and modifications of related technology and civil part. The main subject is replacement of existing relay DGS automations and monitoring system.

Modernization of 400kV line protections EMO – V. Ďúr

Addition of new signal "Automation of switch failure" based on request placed by the transmission system (SEPS).

Modification of emergency steam removal from the reactor cavity to SG box

In case of emergency coolant leak to the refuelling pool and its filling above the level +21.29m, the coolant flows via the supply ventilation duct 1KLA11 to the vent centre rooms, as the spillway level from A004/1 to the air discharge ducts to A201/1 is higher (at +21.76m). Coolant leak via the ventilation system 1KLA11 would result in irreversible primary coolant loss. Passive steam removal system was designed to prevent irreversible coolant leak from the upper part of the reactor cavity. The most suitable solution is installation of closable openings in the emergency steam removal pit in A004/1. Lower edge of these openings must be lower than the lower edge of supply duct 1KLA11 in its uppermost cross-section point.

Hydrogen H2 management in the containment

Severe accident connected with core damaging of pressurized water reactors can result in generation of large volumes of flammable gases (hydrogen, carbon oxide). Both units were equipped with passive auto-catalytic hydrogen recombiners. Their main task is to ensure auto-catalytic reaction on the surface of platinum boards resulting in formation of water or water vapour.

GO suppliers

Business name			
1	Traser spol. s.r.o. Galanta	29	Xervon GmbH
2	VÚEZ, a.s. Levice	30	Termotechna, a.s. Bratislava
3	DEZ spol. s. r. o. Mochovce	31	Vítkovice POWER ENGINEERING
4	ROEZ, s.r.o. Levice	32	Brush SEM s.r.o. Plzeň
5	SAT s.r.o Bratislava	33	Invelt Elektro s.r.o. Plzeň
6	Chladící věže Praha	35	EnerSys s.r.o. Bratislava
7	ČKD Praha DIZ a.s.	36	Brush SEM s.r.o. Plzeň
8	CHEMCOMEX Praha a.s.	37	AT Servis Piešťany
9	VÚEZ, a.s. Levice	38	Stabil s.r.o. Trnava
10	PPA Energo, s.r.o. Bratislava	40	Energovýskum Slovakia a.s.
11	SAT s.r.o Bratislava	41	PPA SERVIS, s.r.o.
12	CHEMCOMEX Praha a.s.	42	DIAMS Bratislava
13	VÚJE, a.s. Trnava	43	EGV Brno
14	VÚJE, a.s. Trnava	44	ZD Rpety
15	VÚJE, a.s. Trnava	45	VÚJE Trnava
16	EVIG Mérnök ,Vállalkozói Kft	47	EGV, spol. s.r.o.
17	ROEZ, s.r.o. Levice	48	PPA ENERGO
18	Energoclima, s.r.o. Piešťany	49	HIT spol. s r.o.
19	Euro pumps Tech s.r.o.	50	HUMA-LAB APEKO, s.r.o.
20	VZT-systémy, s.r.o. Piešťany	51	VÚEZ, a.s. Levice
21	Energoinvest, a.s. Bratislava	52	Chestreal a.s.
22	Energoclima, s.r.o. Piešťany	53	ŠKODA Slovakia, a.s. Trnava
23	UNI - MONT, montážne práce	54	REKO Praha
24	Turbo Car, s.r.o., Veľká Bíteš	55	BSTO LTD
25	PROFESS,spol. s r.o. Plzeň	56	Jaroslav Maľa-BB špeciál
27	PPA Energo, s.r.o. Bratislava	57	GST Service s.r.o.
28	EURO-BUILDING		

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