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REGULATORY INVOLVEMENT IN I&C SYSTEMS UPGRADING ON WWER 440 TYPE REACTORS IN THE SLOVAK REPUBLIC

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ÚJD SR involvement in the process of safety review and consequent regulatory requirements on safety upgrading of I&C systems depends on unit type and on the stage of the individual plant life time.

Operational units of Bohunice V-1 and Bohunice V-2 NPP were subject of safety reviews, being performed at about 10 operational years milestones.

Design safety of Mochovce NPP units 1 & 2 was re-evaluated according to up-to-date safety requirements and safety improvement program was established by the operating organization.

Bohunice V-1 NPP

Safety review was accomplished in 1990 by the specific Committee established by the Ministry of Environment of the Federal Government of the former Czechoslovakia.

At that time no specific recommendations were developed for periodical safety review, or for safety reassessment of operating NPP which was built according to earlier standards. The comparison with internationally accepted safety requirements was used (IAEA NUSS Codes and Guidelines, IEC standards) as the review methodology.

Resulting output in a form of Regulatory Decree was issued in the document which is commonly known as 5/91 Decree of CSAEC.

Specific 11 safety issues (from the total number 81) were addressed directly to I&C area. Number of other safety issues are related to the I&C area undirectly, like requirements for the electric emergency power supply sources, seismical reinforcement, venting, etc. The detailed regulatory requirements addressed to I&C systems in the CSAEC Decree 5/91 were folowing:

Issues concerning the I&C systems included in the CSAEC Decree No. 5/91

Part II

- additional set-points for reactor trip system - HO1 (RTS) actuation and high pressure injection (HPI) pump start-up after pressurizer safety valve stick-open.

Part IV

- cold overpressure of reactor pressure vessel (RPV) protection system
- additional RTS signal (HO-1) in the case of water level decrease in 2 of 6 steam generators (SG)
- additional RTS signal (HO-1) in the case of water level increase in the pressurizer above the set-point
- change of incore power distribution measurement system VOLNA for new system based on selfpowered neutron detectors (KNI)

- to analyze possibilities to delete the HO-2 signal group.

Part VIII
- to analyze operability and availability of sensors in safety systems for environmental conditions (normal and accidental operating conditions), respectively to change those which can not withstand environmental conditions
- to install unit "shut-down" panel
- to provide automatic range-switching of neutron flux measurement system.

Part IX
- to provide logic control of existing emergency core cooling (ECC) systems and in each train to include logic controls for diesel generator (DG) start and power loading sequencer.

Part X
- to provide exchange of fire protection signaling system in main production building for CEREBUS system.

Another principal requirement for V-1 NPP safety upgrading included in Decree 5/91 was to prepare the **program** and design for the **essential safety upgrading** of Bohunice NPPs, units 1 and 2.

The operating organization developed strategy for essential safety upgrading, and for justification of unit safety after reconstruction in accordance with the proposed strategy an Introductory Safety Analysis Report (SAR) was elaborated (reflecting specific legal base valid in the Federal Republic of Czechoslovakia).

Results of safety review of WWER 440/V230 reactor type developed by IAEA (IAEA-TECDOC-640, Ranking of Safety Issued for WWER 440 model 230 NPPs) were used as well as IEC standards for I&C systems in the development of essential strategy and consequent Introductory SAR.

Proposals contained in the **Introductory SAR** for **safety upgrading of I&C** systems can be presented in a very short form by the following way:

Improvement of the (existing) I&C systems:
- separation of protection and control systems
- possibility of the testing during operation (on-line testing and diagnostics)
- classification of the systems, equipment and devices
- seismic qualification of the protection systems
- resistance to fire
- providing the Emergency Control Room (ECR) separated and independent of the main control room (MCR)
- fulfilment of the other requirements and criteria of the applicable standards (for design of the I&C systems important to safety).

In the frame of the I&C improvement and replacement also the new protection functions will be implemented. It means the essential modification of the original design of safety systems.

Scope of the reconstruction

The relevant existing safety systems will be replaced or supplemented by:
- Integrated Reactor Protection System (RPS). The RPS will include RTS and Engineered Safety Feature Activation System (ESFAS)
- Post Accident Monitoring System (PAMS)
- ECR
- Interconnection and interfaces among the safety systems and MCR and ECR
- Ex-core neutron flux measurement
- Process Computer System (monitoring and information function)

Basis and functional requirements of the project

The integrated RPS will automatically perform the following functions:
- RTS
- actuation of the ECCS including start-up (activation) of high pressure and low pressure injection pumps, actuation of emergency power supply systems and confinement isolation.

Design basis of RPS

- Resistance to seismic conditions and other external hazard conditions
- Providing the safety shutdown of the reactor under operating and accidental conditions specified by accident analysis
- Automatic and manual activation of the RPS
- Fail-safe design
- Any failure of the RPS cannot lead to the loss of protection functions
- Intensity of total failure of the reactor protection function will not be higher than 10-5 per year including actuators and emergency power supply systems
- Frequency of the spurious actuation should be set-up as a safety goal

Regulatory assessment and review performed by ÚJD SR using various forms of assistance (including specific IAEA expert mission) finally **resulted** in regulatory **Decree ÚJD SR No. 1/94.**

Specific requirements addressed to I&C area given in this Decree deal with more detailed design requirements for RTS and ESFAS and requirements for ECR. Details in part 5.3 are following:

5.3.1. Upgrade and supplement the reactor protection (RTS) and the unit safety system (ESFAS) in such a way that it complies with the following criteria:

- 1E qualification. When specifying the qualification requirements on the equipment, take into account internal accident conditions according to the accident scenarios included in the Gradual Safety Upgrading
- redundancy 2x100% as a minimum
- to maintain the reliability determined by the Preliminary Safety Analysis Report in such a way that the intensity of a total failure of the reactor protection will not be higher than 10-5 per year and for the unit safety system ESFAS not higher than 10-3 per year, including actuators and power supply
- separation of the protection systems from the control parts of I&C. If signals from qualified equipment are used, ensure a reliable galvanic separation
- direct the output signals from the diagnostics of the protection systems to the appropriate panels in the main control room (MCR)

5.3.2. To analyze situations in which the emergency control room is to be activated, to specify functions that are to be provided from it, and to develop concepts of a separation of ECR and MCR under accident conditions.

5.3.3. To analyze the need for manual group control of the unit safety system (ESFAS) - (manipulations according to the type of accident events)

Bohunice V-2 NPP

The operating organization in cooperation with VUJE Institute based on the operational experience with existing ESFAS made a decision to prepare the Project for replacement of each ESFAS train in both V-2 NPP Units.

This decision was made taking into account the extend of maintenance works required, low-level of self-diagnostic, lack of spare parts and evaluation of safe-failure rate achieved during the previous 10 years of operation. Some essential information concerning the occurrence of spurious operation or test failures at ESFA system can be found in Attachment No. 1.

The pilot project was prepared as the first stage. This included additional back-up redundancy in the first train and channel No. 1 on Unit 3 of V-2 NPP.

Design of this pilot system was based on the hardware-software technology, specifically on SEGELEC hardware products, SEGELEC "fabric-ware" software products and unit specific software developed by VÚJE Institute.

The application for the regulatory review, assessment and approval was made in 1995.

Results of the regulatory assessment are included in ÚJD SR Decrees No. 136/93 and No. 12/94 where implementation of the proposed pilot system was approved, but only the trial

operation of the back-up redundancy (in parallel operation with existing channel No. 1, and signaling operation mode) was permitted.

The pilot system is operated for more as 2 fuel cycles, without any failures.

The project development of overall ESFAS replacement is in the process on the operating organization side.

However, the overall periodic safety review of this twins of reactor units after 10 years of operation has been performed in 1995 in accordance with the Decree 199/91 of CSAEC. Based on this degree the revised version of Operational SAR was developed by the operating organization.

Short-term safety improvement measures have been defined and required for implementation in the ÚJD SR Decree 4/96 based on the review and regulatory assessment of Operational SAR performed by ÚJD SR. Among them requirements directly addressed to I&C systems as short-term safety upgrading measures are following:

* design and implementation of innovated initiating signal concerning the break of main steam header which function was discovered as not satisfactory
* separation of venting systems in MCR and ECR
* RPV cold over-pressure protection system
* to provide 3 independent leak-detection systems for primary coolant leakage.

In addition, the development of the strategy and program of essential safety improvement for Bohunice Units 3 and 4 was required in the Decree 4/96. In I&C area was specifically required:

* to assess individually applicability of IAEA recommendations included in IAEA report "Safety issues and their ranking for WWER 440 Model 213 NPPs" for Units 3 and 4
* to develop strategy for safety upgrading of plant I&C systems. Results of PHARE Program, Project No. 90/062/030/011/EC/ENE/15 "Basic Engineering for Replacement of Instrumentation and Control System for V213 Nuclear Reactor" should be reflected in the strategy
* to specify the list of safety functions and associated systems and equipment that that perform that functions
* to provide program and methods for equipment re-qualification.

Mochovce NPP, units 1 and 2

Safety improvement program in I&C area, which has been developed by the operating organization supported by assistance organizations (EDF, SIEMENS, VUJE, RISKAUDIT, VUEZ, IAEA specific expert mission) in principle follows IAEA recommendations given in the IAEA report „Safety Issues and their Ranking for WWER 440, Model 214".

Generic recommendations for safety improvement have been elaborated in details in the „Technical Specification „ report. Beside 3 general safety issues applicable also to the I&C systems, 12 safety issues in this Program concern directly the I&C area. List of the I&C safety upgrading measures for EMO NPP unit 1 and 2 are following:

I&C	Rank
* I&C Reliability	II.
* Safety system actuation design	II.
* Review of reactor scram initiating signals	II.
* Human engineering of MCR	II.
* Physical and functional separation between the main and emergency control rooms	II.
* Condition monitoring of the mechanical equipment	
* Diagnostic systems of primary circuit	II.
* Reactor vessel head leak monitoring system	II.
* Accident Monitoring System	II.
* Technical support center	II.
* Water chemistry control and equipment monitoring (primary and secondary)	II.
* Replacement of core monitoring systems HINDUKUS and VK3	II.

Recent regulatory involvement is the review and assessment of the operating organization proposal of the time schedule for implementation of safety improvement measures. In this process it should be taken into account the start of different commissioning stages.

Regulatory assessment is in the process and the decision could be prepared by the end of May.

Conclusions

Regulatory involvement into the I&C systems upgrading can be characterized as a unit (Model) specific. Outputs in a form of regulatory decisions compensate in this way the lack of national regulations by specifying the acceptable (international or some national) standards or safety goals in a form of acceptance criteria. This decisions contain also the deadline requirements for safety improvements implementation.

Trnava, March 1997.

Attachment I

Spurious activation of the existent RTS and ESFAS / or failure at the test on operating Units (Bohunice V1 and Bohunice V2) - recent development -

Year	V 1				V 2			
	RTS		ESFA		RTS		ESFAS	
	HO1	other sign.	SA	TF	HO1	other sign.	SA	TF
1994	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
1995	**5**	**0**	**1**	**0**	**0**	**1**	**2**	**2**
1996	**2**	**0**	**2**	**0**	**0**	**1**	**2**	**1**

SA - Spurious activation
TF - Failure at the test