Current approaches to NPP I&C development and implementation in Russia

IAEA TWG NPP I&C, 24-26 May 2011, Vienna

Welcome!
Main Topics

1. Introduction: Main events in Rosatom’s competitive sector since 2009
2. Development of new I&C systems, platforms and infrastructure
3. Modernization of I&C at NPP with WWER
4. Cyber security and sabotage protection
5. Fukushima accident response and recommendations to the IAEA
Introduction: Main events in Rosatom’s competitive sector since 2009 (1)

Simplified structure of State Corporation “Rosatom”

The JSC “Atomenergoprom”, competitive sector comprising nuclear power companies (TVEL, TENEX, “Rosenergoatom” Utility, etc., totally about 90 joint stock companies, including SNIIP)

The state monopolies
- Nuclear weapons sector,
- Science,
- Nuclear & radiation safety,
- Nuclear icebreakers fleet
Significant events:

- Launch of the first floating NPP in S-Petersburg and equipment assembling start-up, June 2010
- Commissioning of Rostov NPP Unit 2, Dec. 2010
- Physical start-up of CEFR (research fast reactor) in China, July 2010
- Physical start-up of Bushehr NPP in Iran, May 2011
- Contracts on construction of new NPPs with WWER at several countries
- New Project on WWER-TOI (Typical, Optimized, Informative, next slide)
- Cooperation with IAEA and WANO: preparation for OSART mission to Smolensk NPP in 2011, WANO mission to JSC “Atomenergoremont” in April 2010, international schools and seminars on nuclear knowledge preservation in Russia in 2010, etc. (MEPHI, JSC “SNIIP”, “Typhoon”)

V. Sivokon, O.Bozhenkov. Reporting on I&C status and recommendations to IAEA. TWG NPPI&C, IAEA, 24-26 May 2011
The strategy of I&C systems development accepted by the State Corporation “Rosatom” is based on stepwise (evolutional) improvement of the design and implementation of new requirements to NPP I&C.
New (in significant part) systems, HW platforms and testing polygons were developed and tested. The main of them are listed below:

- Radiation Monitoring System (RMS) – new SW of upper level with functional enhancement and modernized detectors and controllers, JSC “SNIIP”, JSC “VNIIAES”
- In-core monitoring and diagnostic system – new HW and additional functions, Kurchatov Institute, SNIIP and subcontractors
- TPTS (originally licensed Teleperm-ME, Siemens) - completion of vast modernization, VNIIA
- Reactor protection and control system – first application of AREVA design in Russia for Kola NPP during modernization, VNIIAES and AREVA
- Polygons for I&C testing – completion of creation, VNIIAES, SNIIP
- Reactor protection and control system – new design for research reactors, SNIIP-Systematom
Development of new I&C systems: Radiation Monitoring System (RMS)

New RMS was developed and tested for Kalinin NPP Unit 4. It has the following functional advantages:

- User friendly interface with enhanced navigation via menu, diagrams of technological systems, buildings' maps with sensors' data and elevations, etc.
- Signal filtering and other treatment in accordance with end-user needs.
- Status events analyses at the gateway level to reduce flow rate of status messages to operator.
- On-line simultaneous displaying technological diagrams, compartment maps, tables and charts (when necessary)
- Enhanced calculation functions for better forecast of possible radioactivity releases, radiation dose accumulation and etc.
- More sensitive monitoring of leakages from primary to secondary circuit.
RMS: new video screens on technological systems
RMS: new video screens on compartment monitoring
Development of new I&C systems: In-core monitoring system (ICMS)

- New HW was developed in National Research Centre «Kurchatov Institute» for use in the systems important to safety, first of all for WWER ICMS.

- ICMS is the main tool for monitoring nuclear fuel condition and core processes as well as a mean of reactor thermal power identification.

- National Research Centre «Kurchatov Institute» - designer of up-to-date ICMS for WWER in Russia and abroad (Kozloduy NPP Units 5 and 6 in Bulgaria; Tianwan NPP Units 1 and 2 in China; etc.). Scientific supervisors of this work are Mr. Semchenkov Y. (director) and Mr. Kalinushkin A. (department head)
Development of new I&C systems: In-core monitoring system (2)

ICMS new HW is based on HP ProLiant DL 380 server (3 servers with two 4-cores processors each).

New work station is designed with used of industrial computer system unit SuperMicro, which characteristics are similar to ProLiant DL 380.

Operation SW is based on operating system of UNIX (Linux) type.
Modernization of I&C at NPP with WWER

Significant modernization of I&C systems was completed at several NPPs:

- Control and protection system replacement at Kola NPP (Unit 3) in cooperation with AREVA
- Modernization of APCS and SPDS at Balakovo NPP in cooperation with DS&S (Units 1 and 2)
- Modernization of APCS at Kalinin NPP in cooperation with Tecnatom (Unit 1)
- Modernization of APCS at Novovoronezh NPP (Unit 5)
Cyber security and sabotage protection: Risk assessment

- Vital compartments security
- Reactor building security
- Reactor core impact
- Plant security
- Detailed data on safety critical systems design

Must be restricted
Virus attack and sabotage protection: Task distribution

Sabotage Protection

Security (physical protection)

Different organizations and methods, minimum common cause failures

Special I&C design and eng. means
Examples of special engineering means for virus attack protection

- Built-in protection of passive type (complicated but possible in some cases)

- Additional passwords or predefined rules for changing reactor protection set-points and algorithms

- Build-in checks of SW operation

- Special modification of well-known COTS HW and SW for use in safety critical systems

- Extension of use of national HW & SW platforms for safety critical applications

- Development of national operating system based on Linux (plan for 2012)

- Increase diversity, use FPGA and PLC, etc.
Russian TPTS PLC (originally licensed Teleperm-ME) was significantly modified

- Industrial Fast Ethernet Technology
- 100 MHz fiber optic data transmission
- Fault tolerant circle structure
- Bus can withstand terminal unit failure
- Fast “supermodules” for special tasks
Fukushima accident response and general recommendations to the IAEA

- To analyze the accident in details and be focused on I&C operation during and after the accident
- To make recommendations to authorized national and international regulatory bodies & organizations on reconsideration of safety categorization of NPP systems, including I&C systems
- To increase robustness, reliability and post accident operation capabilities of NPP systems, including I&C.
- To extend a scope of post accident monitoring, particularly radiation monitoring, to enhance post accident management guidance
- To revise the standards on NPP systems design and qualification where necessary
- Enhance system of international data exchange on significant incidents and accidents
Particular recommendations to IAEA TWG on NPP I&C (1)

Enhancement of digital control and protection systems design and quality:

✓ Reconsider I&C systems safety categorization to more strict solutions where necessary
✓ Increase the level of safety systems diversity and avoidance of the common cause failures
✓ Qualification requirements (more strict for robustness, reliability, external impact)
✓ Scope of post accident monitoring, increase especially for radiation monitoring
✓ To organize IAEA missions for I&C design assessment at new and old NPPs
Optimization of the HMI for MCR and other control rooms:

- Functional analysis, methods, technical means and experience of MCR design with specific tools (CRP or a new TECDOC?)
- Analysis of mnemonic symbols used to display the process equipment on MCR screens, unification of designations
- Navigation in computer based control systems (soft control via APCS), new technical means for computerized control
- Determination of an optimum balance of computerized and analogue (reserve) control
Cooperation in the field of information technologies development and information exchange:

✓ Enhance international data exchange of significant incidents and accidents paying special attention to I&C operability

✓ Develop and extend existing Knowledge Portals for NPPs and operating organizations

✓ Develop and use taxonomies on main type of NPPs to create comprehensive information systems on design and technologies, OPEX

✓ Maintain actual databases (standards, design documents, equipment 3-D models, operational experience, etc)
Thank you very much!