UKRAINE

Updated National Action Plan

ENSREG
2nd National Action Plan Workshop
Brussels
20-24 April 2015

Contents

Nuclear Power Plants of Ukraine

Overview of the Updated NAcP

- The National Action Plan of Ukraine was updated in compliance with the Terms of Reference for 2nd ENSREG workshop:
  - progress in implementation of safety measures
  - schedule for the remaining measures

- Transparency of the NAcP updating:
  - published at the SNRIU site (www.snrc.gov.ua)
  - progress in implementation of safety measures discussed at open SNRIU Board meeting with involvement of all stakeholders, non-government organizations and mass media

Changes in the NAcP since 2013

- The number of safety measures has not changed
- The scope of measures remains unchanged
- The safety upgrade schedule has been refined to:
  - reflect the experience in implementation of measures at pilot units
  - consider technical challenges and results of analytical studies
  - consider financial constrains due to the current political situation
  - allow for complicated tendering procedure

Evolution of the Safety Upgrades Program for Operating NPPs

"Old" units

"New" units (K2R4)

Comprehensive Program of NPP Modernization and Safety Upgrade

K2R4 Modernization Programme

Safety Upgrade Concept for existing NPP Units

Comprehensive (Integrated) Safety Improvement Program (2011-2017*)

Results of Joint IAEA-EU-Ukraine project

Measures resulting from stress tests

Strengthening of regulatory requirements

Progress in NAcP implementation

- **General information:**

-significant progress achieved for all pilot units (all measures were implemented in adopted scope for SUNPP-1 as LTO conditions)

-on-going activities at non-pilot units taking account the experience gained from pilot units

-almost all measures performed at ChNPP

- **Systematic approach to implementation of safety measures:**

- general conceptual decision for strategy that combines several technical measures to cope with SBO and LUHS
- initial implementation at pilot units with reactors of each design and afterwards at other units
- site-specific SARs to justify effectiveness of the SBO/LUHS strategy with different combinations of mobile equipment, times for its delivery to the connection places, operator actions

Key measures – Topic 1 (1/4)

- **Seismic qualification**

Qualification is based on the values refined upon site seismic survey

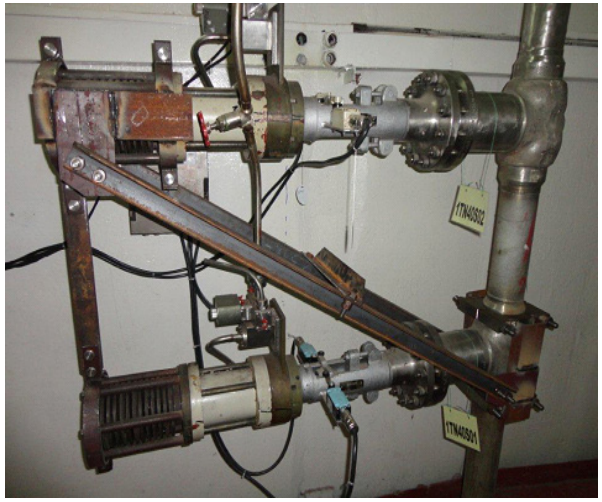
	Design-basis PGA		Refined PGA value	
NPP	SL-1/OBE	SL-2/SSE	Refined SSE	PGA value for qualification
Khmelnitsky	0.025g	0.05g	0.08g	0.1g
Rivne			0.08g	0.1g
South-Ukraine			0.093g	0.12g
Zaporizhya			0.115g	0.15g

Key measures – Topic 1 (2/4)

Progress in seismic qualification:

-SUNPP-1 - completed (2414 pieces of equipment, qualification of 1461 pieces was increased, 194 pieces of equipment were replaced)

-on-going for other units – 2015-2017



Key measures – Topic 1 (3/4)

- **Seismic monitoring system**

-SUNPP site – completed

-ZNPP site – under completion:

✓equipment for 6 points of seismic monitoring in ZNPP 25 km

✓drilling to install seismometers, protective structures

✓ trial operation planned in 2015

✓temporary seismic monitoring system (3 seismometers) working now

-RNPP and KhNPP – on-going

✓equipment purchasing

✓mounting work

Key measures – Topic 1 (4/4)

- **Functionality of group A equipment in case of the loss of service water system due to tornado**

– SUNPP-1 – completed (mobile pumping station 396 m^3/h, 10 кgf/cm^2, procedure for alternative water supply from the mobile pump to essential loads with water intake from two alternative sources: water intake pools of ventilation cooling towers or water channel of the Tashlyk reservoir)

– Schedule for others units:

- SUNPP-2, ZNPP-1-3,5, RNPP-3, KhNPP-1 – 2016
- remaining units – 2017

Key measures – Topic 2 (1/3)

▪General strategy for SBO/LUHS

-SG depressurization by steam dump to atmosphere (BRU-A) or SRV

-SG feed:

✓ from mobile diesel-driven pump (MDP) connected to emergency feedwater system (EFW) line (additional bunkered EFW for WWER-440)

✓ passive dearator depletion (+ approx. 8.5 hrs to core damage)

-RCS boron injection by high pressure ECCS (powered from mobile DG)

-Spent fuel storage pool feed/cooling by MDP

-Support functions

- ✓alternative power supply (0.4 kV/800kW MDG)
- ✓essential service water (ESW) supply by MDP
- ✓compressed air
- ✓I&C (PAMS)

Additional equipment - 3 mobile diesel-driven pumps (SG feed, SFSP feed, ESW) and mobile DG / per power unit

Key measures – Topic 2 (2/3)

Alternative power supply in case of SBO (SUNPP-1 examples)

0.4 kV/800 kW mobile DGs

Key measures – Topic 2 (3/3)

Mobile pump to feed SG/SFP

Connection places installed for SFP water supply

Key measures – Topic 3 (1/6)

SAMG implementation

■SAMG for operation at rated power

-implemented at pilot RNPP-1, SUNPP-1 and ZNPP-1 units, personnel trained

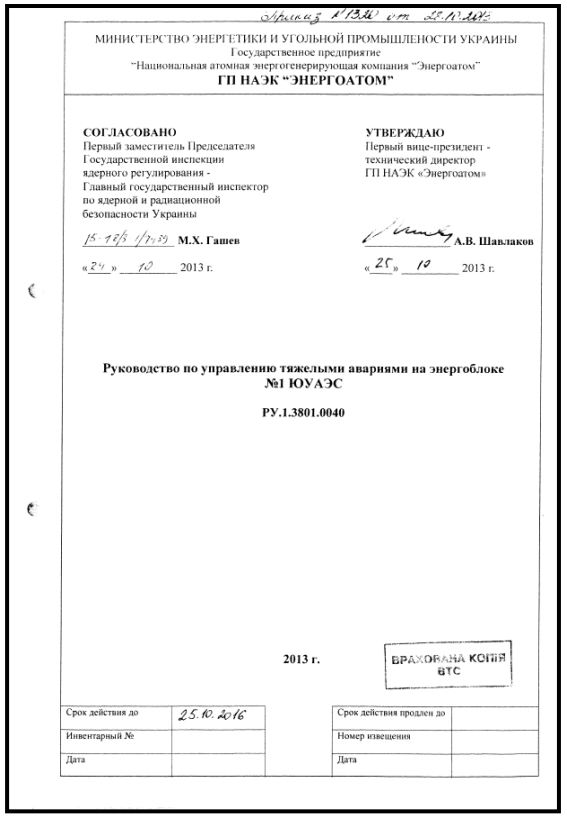
-developed and being revised for all non-pilot units (to be implemented in 2015)

■SAMG for low power and shutdown states/SFP

-developed and being revised for pilot units

-implementation schedule:

- pilot units – 2015
- non-pilot units - 2016



МИНИСТЕРСТВО ЭНЕРГЕТИКИ И УГОЛЬНОЙ ПРОМЫШЛЕНОСТИ УКРАИНЫ
Государственное предприятие
"Национальная атомная энергогенерирующая компания "Энергоатом"
ГП НАЭК "ЭНЕРГОАТОМ"

СОГЛАСОВАНО
Первый заместитель Председателя
Государственной инспекции
ядерного регулирования -
Главный государственный инспектор
по ядерной и радиационной
безопасности Украины
М.Х. Гашев
«24» 10 2013 г.

УТВЕРЖДАЮ
Первый вице-президент -
технический директор
ГП НАЭК «Энергоатом»
А.В. Шавлаков
«25» 10 2013 г.

Руководство по управлению тяжелыми авариями на энергоблоке №1 ЮУАЭС

РУ.1.3801.0040

2013 г.

ВРАХОВАНА КОПІЯ ВТС

Срок действия до	25.10.2016	Срок действия продлен до	
Инвентарный №		Номер извещения	
Дата		Дата	

Key measures – Topic 3 (2/6)

- **Containment filtered venting system**

– 1st stage (intermediate) - containment venting through existing exhaust air ducts and further release of the steam-gas medium to atmosphere through the ventilation stack and treatment on available iodine and airborne filters

  - Completed for SUNPP-1 – replacement of air ducts, upgrading discharge line

– 2nd stage – additional filtered venting:

  - analytical justification for filters completed, technical specifications approved, procurement procedures for SUNPP-1, ZNPP-1,2
  - implementation schedule for SUNPP-1 – 2015, SUNPP-2, ZNPP-1,2-2016, remaining units - 2017

Key measures – Topic 3 (3/6)

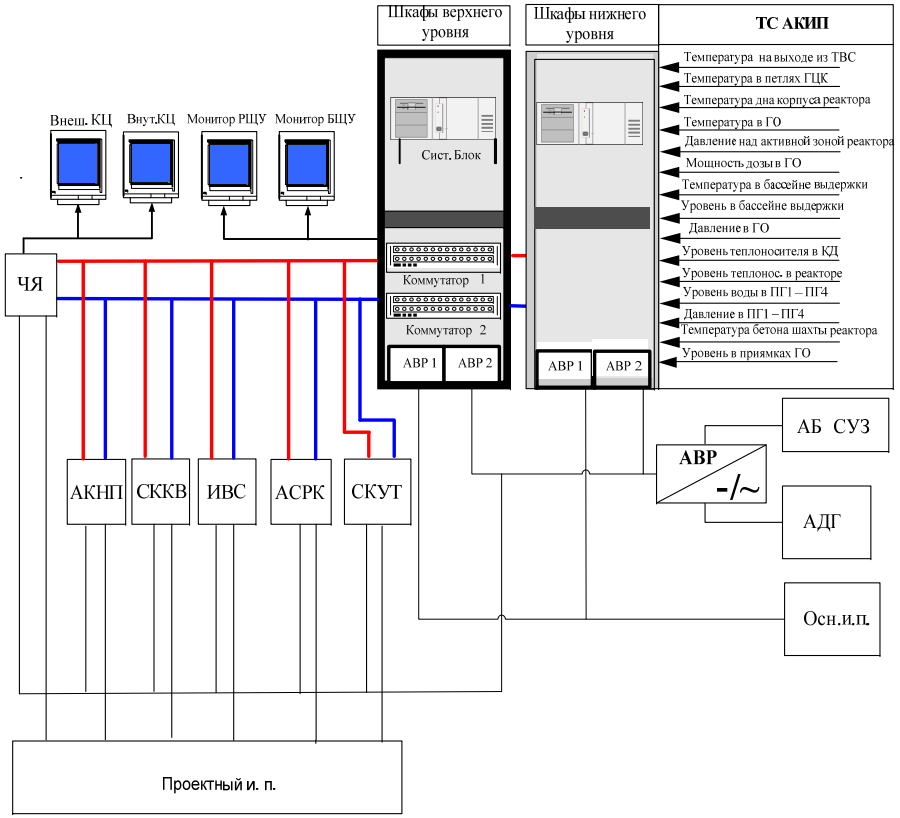
- **Post accident monitoring system (PAMS)**

– 1st stage:

- software based I&C (upper level of PAMS)
- emergency instrumentation of coolant level in reactor
- connection of existing design basis sensors to upper level of PAMS

– 2nd stage:

- implementation of emergency instrumentations, qualified for severe accident conditions



Key measures – Topic 3 (4/6)

- **Implementation progress**

✓SUNPP-1 - software based upper level PAMS designed and produced by Ukrainian "Westron" company, installed and put into trial operation, equipment purchased for providing information to emergency centers, in-core coolant level measurement improved

✓ZNPP-1 - software based upper level PAMS designed and produced by Ukrainian "Impuls" company, installed and put into trial operation

- **List of monitored parameters for SAMG strategies:**

1. Temperature at fuel assembly outlet 2. Level in the reactor 3. Pressure above the core 4. Temperature of the reactor vessel bottom 5. Temperature in the containment 6. Concentration of hydrogen	7. Gamma radiation dose rate in the containment 8. Pressure in the containment 9. Temperature in fuel pool 10. Level in fuel pool 11. Water level in the pit of containment

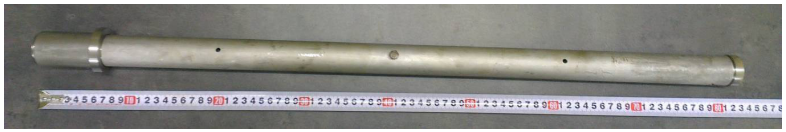
Key measures – Topic 3 (5/6)

Measurement of dose rate with BDRG-47R by “Technopole”, or upgraded GIM-206 by MIRION

Reflectometry radar-sensor by "AMICO kit" (Mykolayiv) to measure the level of liquids (including boiling) in spent fuel pool with temperatures up to 300 C.

Measuring range 0 - 16 m.

Accuracy - 4 cm.



Measurement of pressure in the primary circuit, pressure in the containment, level in the pit GA201/1,2,3 using pressure sensors of PJSC "Manometer-Kharkiv"

Measurement of temperature using platinum resistance thermometers and thermocouples made in Ukraine by “Thermoprilad” or “Omega”

Key measures – Topic 3 (6/6)

Installation of passive autocatalitic recombiners (PARs) in the containment dome

Concrete barrier in the melt spreading area to avoid containment bypass (WWER-1000/V-302 peculiarities)

Key measures – Topic 4

- **Harmonization of NPP safety requirements with WENRA reference levels**

- Self-assessment for compliance with previous RLs and preparation of the Action Plan in 2013. The measures to be implemented within annual rule-making activities

-Self-assessment for compliance with the RLs for existing reactors taking into account the lessons learned from the TEPCO Fukushima Daiichi Nuclear Accident (October 2014) under the approaches and methodologies developed by RHWG jointly with all WENRA member states

-In Geneva on 26 March 2015, Ukraine was accepted as a WENRA member

Key measures – Topic 5 (1/2)

- **NPP emergency exercises**

Conducted:

– Khmelnitsky NPP – 29.05.2013

– Rivne NPP – 05.11.2014

Scenario “Meteorological hazard at the place of the NPP location and associated blackout of the NPP and failure of the cooling systems”

Planned:

– South-Ukraine NPP – 22.04.2015

– Zaporizhya NPP – 3.12.2015

Key measures – Topic 5 (2/2)

- **SNRIU Information and Emergency Centre**

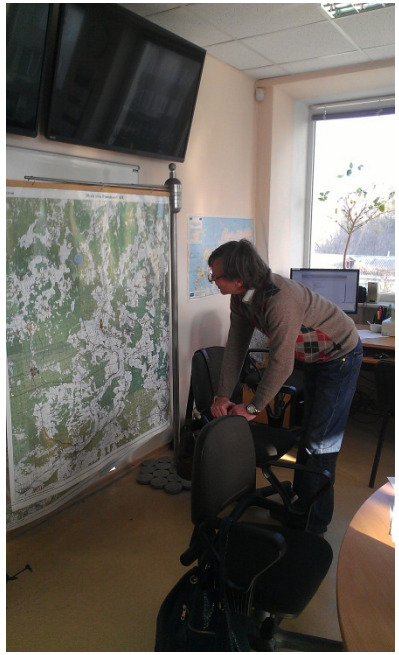
– Joint NPP emergency exercises

– International training conducted by the IAEA (ConvEx-3; ConvEx-1a; ConvEx-1b (2013), ConvEx-2b; ConvEx-2d; ConvEx-1a; ConvEx-1b (2014), ConvEx-2a (2015))

– Communication tests (Austria, Belorussia, Bulgaria, Latvia, Germany, Norway, Poland, Romania, Slovakia, Turkey, Hungary, Finland, Sweden (2013, 2014), Bulgaria, Romania (2015))

– Improvements under consideration:

- enhancement of the communication and security means
- establish a backup emergency center



Key measures at Chornobyl NPP (1/2)

- **All undamaged spent nuclear fuel of the Chornobyl NPP is currently removed to the interim spent fuel storage facility (ISF-1)**
- **Transportation of the damaged spent fuel from the SFPs of units 1 and 2 to the ISF-1 is planned for 2015**
- **Implemented measures:**

– additional mobile DG for power supply to ISF-1

Key measures at Chornobyl NPP (2/2)

- **Implemented measures (cont.):**
  - – seismic resistance analysis for safety related ISF-1 civil structures (0.1 g, safe shutdown earthquake for the ChNPP site is 0.06 g)
  - – seismic resistance analysis for ISF-1 lining (0.1 g)

- **On-going measures:**
  - – purchase of a new container for transportation of spent fuel assemblies
  - – assessment of safety margins and potential failures under loads induced by a tornado of class F 3.0

Good practices

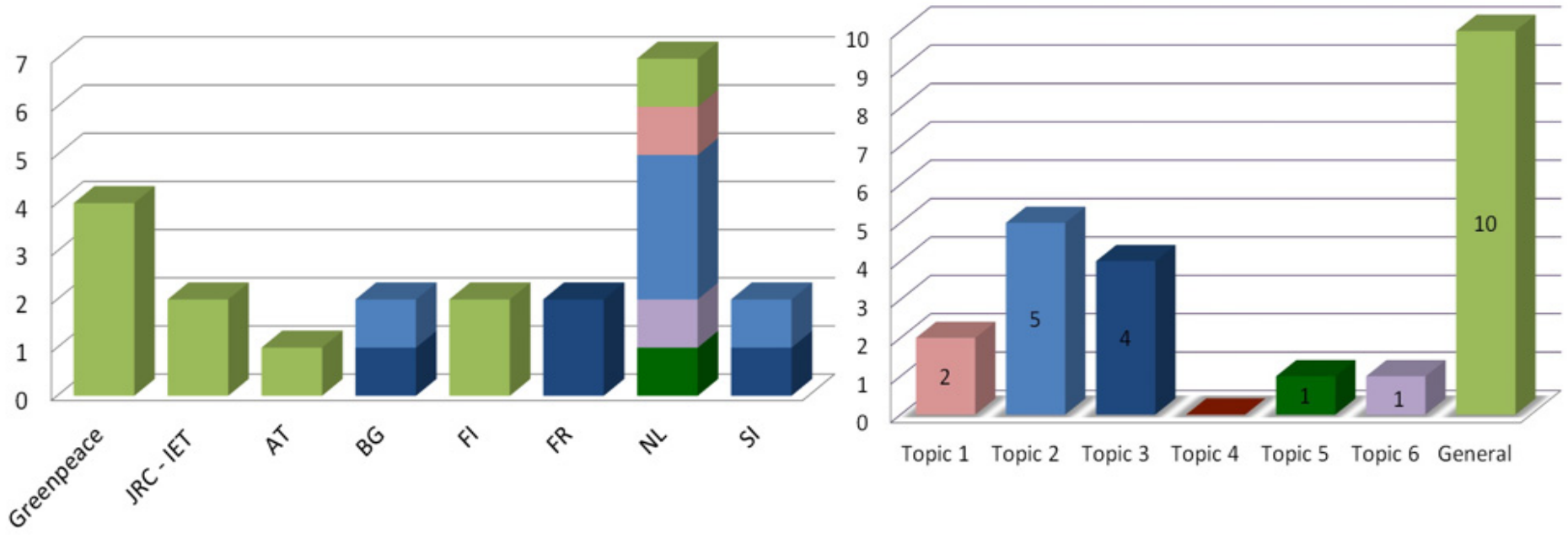
- **Regulatory body monitors, in a systematic manner, implementation of the measures at open Board meetings and during planed inspections. Regulatory body has requested to implement a series of post-Fukushima upgrades as a condition for LTO**
- **Measure is first implemented at pilot power units to cover reactors of each design and then at other units taking into account the experience gained from the pilot one (results, technical solutions and findings)**
- **NPP emergency exercises on the Fukushima related scenario with the activation of SNRIU emergency center**

Challenges

- The schedule for safety measures is affected by the technical complexity of their development and implementation, and required scope of funding
- For measures on severe accident management, analytical/experimental studies of relevant severe accident phenomena are to be continued

Response/clarification on the questions/comments raised in the 2014 version of NAcP

Distribution of Questions



Topic 1 - Natural Hazards

Topic 2 - Loss of Safety Systems

- General

Topic 3 - Severe Accident Management

Topic 4 - National Organizations

Topic 5 - Emergency Preparedness and Response

Topic 6 - International Cooperation

Country Specific Questions – General

Questions: **The schedule and general approach of the measures implementation, conditions for long term operation (AT, FI, NL)**

Answer (1/3):

- Measures resulting from the stress-tests and peer-review have been included into the Safety Upgrade Package (Comprehensive safety improvement program), that is approved by the Government of Ukraine
- Scope and schedule for existing safety measures of Safety Upgrade Package have been revised and amended with due consideration of their relevance in the light of the Fukushima accident
- Schedule for implementation of measures is approved by SNRIU and refined on the annual basis (to reflect the experience in implementation of measures at pilot units and results of analytical studies, to consider the technical challenges)

Country Specific Questions – General

Answer (2/3):

- SNRIU monitors in a systematic way the implementation of measures at annual Board meetings (Jan. 2015, February 2014) and during planed inspections (e.g. April 2015 at SUNPP, Dec. 2014 at ZNPP). The results are publicly available at SNRIU website (www.snrc.gov.ua)
- SNRIU has required to implement a set of post-Fukushima upgrades as conditions for LTO, namely:

-equipment qualification (harsh environments and seismic impacts)
-functionality of safety systems in case of the loss of service water system
-SG and SFP makeup and cooling in long-term SBO conditions
-emergency power supply in long-term SBO conditions
-accident and post-accident monitoring system (PAMS)
-SAMGs implementation
-containment venting system (WWER-1000)

The comprehensive list of measures has been adopted at the SNRIU Board meeting

Country Specific Questions – General

Answer (3/3):

- For those units that are currently under lifetime extension process, the utility made a decision to implement the remaining hardware safety upgrades during a long outage period before obtaining a license for long-term operation. For other units, all measures are implemented stepwise according to the annual schedule
- Even if the unit will be shut down when its design life expires, the SNRIU has adopted a list of measures relevant to heat removal from spent fuel to be implemented

Country Specific Questions – Topic 1

Question: **A methodology for seismic walkdowns is implemented. Will Ukraine also implement procedures for walkdowns for flooding and extreme weather?(NL)**

Answer:

- Seismic walkdowns were performed as a part of the seismic qualification process based on the internationally recognized GIP-WWER methodology
- Walkdowns on all external hazards have been done immediately after the Fukushima accident and within the stress-tests
- Dedicated flooding and fire walkdowns were done for development of PSA for internal and external hazards
- Operating procedures include the provisions on routine walkdowns to check condition of the water drainage system, etc.

Country Specific Questions – Topic 2

Questions: **Details on the safety features to ensure the safety functions in case of SBO and/or loss of UHS (dealing with loss of ultimate heat sink, bunkered systems) (NL, SL)**

Answer (1/2):

▪Additional safety features in case of SBO/LUHS conditions (per unit):

-SG makeup from mobile pumps

-SFP makeup from mobile pumps

-service water feeding from mobile pumps

-mobile DG-0.4 kV 800 kW (to supply power to 0.4 kV HPIS pumps (TQ14), safety relief valves, battery recharging, emergency lighting , etc.)

Analysis of the primary makeup necessity and possibilities from the mobile pumps is on-going

Country Specific Questions – Topic 2

Answer (2/2):

- The utility relies on mobile equipment with specific high requirements for withstanding external hazards. For WWER-440, additional bunkered EFW system was installed previously in a separate seismic-proof building
- Storage of mobile equipment, its transportation, and connection places are designed so as to exclude common-cause failures and ensure their operability
- In case of the loss of UHS:

-feed&bleed by the secondary side using mobile pumps
-service water feeding from the mobile pumps using alternative water sources

Country Specific Questions – Topic 2

Question: **Would you please explain how do you provide make up and cooling of spent fuel pools using the SFP cooldown system for normal operation in case of loss of power supply and impossibility to open the pneumatic isolation valves? (BG)**

Answer:

- Different possibilities of SFP cooling are ensured (SUNPP-1 example):

-restoring the normal SFP cooldown system (TG10(20)D01 (110 kW) by power supply from MDG 0.4 kV (800 kW) and service water feeding from mobile pumps)
-SFP makeup using TM pumps and ECCS tanks (TM31(32)D01 (15 kW) power supply from the MDG 0.4 kV (800 kW)
-SFP makeup from the mobile pumps

- To open the pneumatic isolation valves, air compressors are going to be supplied from the mobile DGs

Country Specific Questions – Topic 2

Question: **Regarding the situation in Ukraine. Has there been an analysis performed on the influence of this situation in Ukraine on certain scenarios evaluated in the Stress-test? It is imaginable that for example the chance on large scale blackouts has increased significantly. If this would be true, it could be a reason to give higher priority to some of the proposed improvements. Was a reasoning like this evaluated and a reason for a readjustment? (NL)**

Answer:

- Safety improvement measures are under implementation to ensure performance of the main safety functions in case of SBO and LUHS conditions and do not depend on the causes of these conditions
- Special emergency training on large-scale blackouts has been already requested by the SNRIU and scheduled by the utility for the fourth quarter of 2015
- The adequate quantity and capacity of mobile equipment are ensured for multiunit accidents

Country Specific Questions – Topic 3

Question: **Could Ukraine detail the actions with regards to simultaneous accidents in reactor and SFP (with several units affected)? (FR)**

Answer:

- Simultaneous accidents in reactor and SFP are analyzed within SAMG development, covering the reactor core and SFP in different modes. The timing of accident progression in the core and SFP is substantially different
- Several examples of the mutual effects for reactor core and SFP:

-generation of additional quantity of hydrogen in SFP

-operator's post-accident actions on re-opening of pneumatic valves at SFP line after closure due to LOCA at reactor

-containment venting system - it is necessary to take into account that pressure decrease may lead to more intensive water boiling in SFP

- The amount of mobile equipment is selected based on the assumption of a multiunit accident (a separate set of equipment for each unit)

Country Specific Questions – Topic 3

Question: **Regarding provision of instrumentation during and after accidents, could you please give some details on the qualification of the instrumentation? What are the requirements for qualification? (SL)**

Answer:

▪Qualification requirements for I&C PAMS equipment include:

-operability under hazards and severe accident conditions (high temperature, pressure, radiation, seismic), resistance to spray (for I&C inside containment)

▪I&C availability during SBO:

-dedicated batteries to be provided as a part of PAMS enabling at least 8 h of operation, MDG for longer SBO conditions

Environmental conditions	DBA	SA
Temperature, °C	150	250
Pressure, MPa	0.54	1.05
Relative humidity, %	100% of steam	
Dose rate, Gr/h	10^3	$2*10^4$
Duration of regime, h	10	72

Country Specific Questions – Topic 3

Question: **Analysis of the need and possibility to qualify power unit components that may be involved in SAM for harsh environments. 1) What are the main results of the analysis? 2) Are there any corrective measures proposed? (BG). Could SNRIU clarify what is the status of the new PORVs concerning their qualification in case of SA? (FR)**

Answer:

- The utility has submitted for review a preliminary analysis on SAM equipment that need qualification for harsh environments:

-boundary accident scenarios were identified for harsh environments - (SBO+LOCA) with containment isolation

-list of the equipment is needed for SAMG strategies

The SNRIU has requested to update the analysis according to the review results. Further work is needed

- PORVs for all units were qualified for feed&bleed. The PORV credit in severe accident conditions should be justified additionally to prove that core melting at high primary pressure can be avoided

Country Specific Questions – Topic 5

Questions: **Rodos is a decision support system. Source estimation will be input to Rodos? Are actual plant data during an accident of all NPPs available in the Emergency Centre of Ukraine? And what method is used to make a proper estimation of the source term during an accident? (NL)**

Answer:

- RODOS system is currently under trial operation at two pilot sites – ZNPP and RNPP. It is operated locally and in the emergency centre of the regulatory body using on-site radiation monitoring data and region-specific weather forecasts. Implementation of the RODOS system for SUNPP and KhNPP is being performed by Energoatom and State Emergency Service of Ukraine and is to be completed in 2015. RODOS allows making a proper estimation of the source term during an accident using the data from off-site monitoring posts
- Actual data from all NPPs during an accident as well as during routine operation are available in emergency centers of NPPs, operating company and regulatory body. Data (technical parameters, meteorological and radiation monitoring data) are transferred by the Automatic Remote Control System

Country Specific Questions – Topic 6

Questions: **Ukraine always had access to the relevant engineering information of their NPPs provided by the Kurchatov Insitute. Does Ukraine have access to this information in the present political situation? Are there any alternative sources available? (NL)**

Answer:

- The safe operation of Ukrainian NPPs can be completely managed by Ukrainian organizations (incl. design, engineering, maintenance and equipment replacement)
- Utility keeps contact with the design and scientific organizations of Russian Federation (e.g. on fuel issues)
- Technical and scientific support is also received from EC through INSC program, bilateral agreements

Country Specific Questions – General

Question: **The action related to the decisions on the management with large volumes of contaminated water is interesting since not many countries are having any measures related to this topic. Are there any preliminary results concerning the analyses? (FI)**

Answer:

- Conceptual approaches to the management with large volumes of contaminated water are under preliminary discussion, no technical solution at this moment
- As regards Chornobyl NPP, the liquid radwaste treatment plant was put into operation at the end of 2014 at Chornobyl NPP site (capacity is 10 m3/day)


THANK YOU FOR YOUR ATTENTION!