



Updated National Action Plan



State Nuclear Regulatory Inspectorate of Ukraine

Kyiv
2015

INTRODUCTION

In June 2011, Ukraine joined the European initiative of conducting stress tests at nuclear power plants in EU member states and neighboring countries (Stress Test Declaration). The stress tests were performed at Ukrainian NPPs in compliance with the stress test specifications agreed by the European Commission and ENSREG (13 May 2011, Declaration of ENSREG, Annex 1: EU Stress Test Specifications). The stress tests were focused on:

- Zaporizhzhya NPP units 1-6 (WWER-1000/320) and dry spent nuclear fuel storage facility (DSF) located on the Zaporizhzhya NPP site;
- Rivne NPP units 1, 2 (WWER-440/213) and units 3, 4 (WWER-1000/320);
- South Ukraine NPP unit 1 (WWER-1000/302), unit 2 (WWER-1000/338) and unit 3 (WWER-1000/320);
- Khmelnytsky NPP units 1, 2 (WWER-1000/320);
- Chornobyl NPP units 1-3 (spent fuel pools) and interim spent fuel storage facility (ISF-1) located on the Chornobyl NPP site.

The State Nuclear Regulatory Inspectorate of Ukraine (SNRIU) submitted the National Report developed in line with ENSREG recommendations to the EU Stress Test Secretariat on 30 December 2011 to be peer reviewed further.

ENSREG set forth results from the peer review of stress tests for EU states and neighboring countries (Ukraine and Switzerland) in the summary peer review report and country-specific reports.

The peer review country report for Ukraine concluded that the National Report of Ukraine complied with the ENSREG specifications, provided sufficient information to understand the design basis for external natural events, and identified adequate measures to compensate for safety deficiencies revealed. In addition, it was pointed out that previously planned NPP safety improvements should be completed.

The summary EC documents developed upon the peer review of stress tests and approved by the EC on 3 October 2012 set forth recommendations for the SNRIU to monitor, in a systematic manner, implementation of the measures identified upon stress tests by the operating organization. Along with recommendations for the SNRIU, the EC documents also outline good practices revealed in the peer review process.

In order to monitor the implementation of safety improvements at Ukrainian NPPs identified in the stress test and peer review processes, the SNRIU Board convened on 20 November 2012 to hold an open meeting. The SNRIU Board identified additional safety improvements related to severe accident management to take into account peer review recommendations.

The National Action Plan was developed at the beginning of 2013 to implement recommendations of the peer review of stress tests at Ukrainian NPPs and to ensure that the operating organizations take safety improvements identified upon stress tests and the SNRIU efficiently monitors this process.

The ENSREG summary report upon results of the workshop held on 22-26 May 2013 to discuss national action plans (ENSREG National Action Plans Workshop. Summary Report) indicated the following conclusions on the National Plan of Ukraine:

- The National Action Plan of Ukraine complied with the ENSREG recommendations on the format of national action plans and covered all necessary aspects;
- There were no open issues or additional questions for Ukraine upon the workshop.

In order to prepare for the ENSREG workshop to be conducted on 20-24 April 2015 to review and discuss the current status of measures identified in the national action plans, the National Action Plan of Ukraine was updated in compliance with the recommendations provided in the 'ENSREG Post-Fukushima National Action Plans Workshop 20-24 April 2015. Terms of Reference'.

It should be noted that the number of safety improvement measures has not changed for operating NPPs and Chornobyl NPP in the updated National Action Plan; the scope of measures remains unchanged as well.

The updated National Action Plan specifies the current status of safety improvement measures and schedules for their implementation.

Part I "Safety Improvement Measures" of the updated National Action Plan provides a list of measures identified by the National Action Plan upon Stress-Test Results (2013) for operating NPPs and Chornobyl NPP with renewed information on the status and schedule of measures.

Part II "Status of Safety Improvement Measures" of the updated National Action Plan presents more detailed information for each of the measures, namely: short description of the planned scope for implementation, status of implementation (more detailed information is provided for completed measures) and revised schedule.

It should be emphasized that the schedule for a series of safety improvement measures at operating NPPs that require substantial funding has been extended, taking into account the situation on the territory of Ukraine over the last year and the decision made by the operating organization to shut down the power units when their design-basis life expires in order to implement all safety improvement measures needed to justify long-term operation.

The Annex to the updated National Action Plan contains the National Action Plan upon Stress-Test Results (2013).

ABBREVIATIONS

C(I)SIP	Comprehensive (Integrated) Safety Improvement Program for Ukrainian NPPs
ChNPP	State Specialized Enterprise 'Chornobyl NPP'
DG	Diesel Generator
EC	European Commission
ECR	Emergency Control Room
Energoatom	National Nuclear Operator 'Energoatom'
EOP	Emergency Operating Procedure
EU	European Union
IAEA	International Atomic Energy Agency
ISF	Interim Spent Fuel Storage Facility
KhNPP	Khmelnitsky Nuclear Power Plant
MCR	Main Control Room
NPP	Nuclear Power Plant
PAMS	Accident and Post-Accident Monitoring System
PAR	Passive Autocatalytic Hydrogen Recombiner
PSA	Probabilistic Safety Assessment
RNPP	Rivne Nuclear Power Plant
SAMG	Severe Accident Management Guideline
SFA	Spent Fuel Assembly
SFP	Spent Fuel Pool
SG	Steam Generator
SSE	Safe Shutdown Earthquake
SUNPP	South Ukraine Nuclear Power Plant
UARMS	Unified State Automated Radiation Monitoring System in Ukraine
VS	Ventilation Stack
WWER	Water-Cooled Water-Moderated Power Reactor
ZNPP	Zaporizhzhya Nuclear Power Plant

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Part I. Safety Improvement Measures

Table 1.1 Measures Identified upon stress test at Operating NPPs

No	Measure / activity	Recommendations at European level	Recommendations at national level	Schedule/Status		
				¹ WWER-440/213	² WWER-1000/320	³ WWER-1000/302, 338
Natural Hazards						
1.	Equipment qualification (harsh environments and seismic* impacts)	(5), (6), (11), (13)	[1], [2]	*2016/2016 ongoing	2015/2017 ongoing	completed/2016 ongoing
2.	Seismic resistance of structures, systems and components important to safety	(5)	[1], [2]	2017/2017 ongoing	2017/2017 ongoing	completed/2015 ongoing
3.	Consideration of a full range of initiating events for all reactor and SFP states in PSA	(5)	[1], [2]	2017/2017 ongoing	2015/2017 ongoing	completed/2016 ongoing
4.	Implementation of a seismic monitoring system at NPP sites	(10)	[1], [2]	SUNPP – 2012/completed ZNPP – 2017 /ongoing RNPP – 2016/ongoing KhNPP – 2017/ongoing		
Loss of Safety Systems (Loss of Power and/or Ultimate Heat Sink)						
5.	SFP makeup and cooling in long-term station blackout conditions	(14), (17), (23), (24), (26), (27), (28)	[1], [2]	2017/2016 ongoing	2016/2017 ongoing	completed/2015 ongoing
6.	SG makeup and cooling in long-term station blackout conditions	(14), (17), (24), (26), (27), (28)	[1], [2]	2017/2016 ongoing	2016/2017 ongoing	2015/2016 ongoing
7.	Improved reliability of emergency power supply	(15), (16), (17), (18), (22), (24), (26), (27), (28)	[1], [2]	–	–	completed/2016 Ongoing

¹ RNPP unit 1 / unit 2

² Pilot unit (ZNPP-1) / final period for implementation of the measures at all power units of this design.

According to national safety regulations, a measure is first implemented at the pilot power units with reactors of each design and then at other units taking into account the pilot experience

³ SUNPP unit 1 / unit 2

No	Measure / activity	Recommendations at European level	Recommendations at national level	Schedule/Status		
				¹ WWER-440/213	² WWER-1000/320	³ WWER-1000/302, 338
8.	Emergency power supply in long-term loss of power	(15), (16), (17), (18), (22), (24), (26), (27), (28)	[1], [2]	2017/2016 ongoing	2016/2017 ongoing	–
9.	Functionality of group A equipment fed from the service water system in case of water discharge in spray ponds	(17), (24), (26), (27), (28)	[1], [2]	2017/2016 ongoing	2016/2017 ongoing	–
10.	Functionality of group A equipment fed from the service water system in case of failure of ventilation cooling towers and/or service water supply pumps	(17), (24), (26), (27), (28)	[1], [2]	–	–	completed/2016 ongoing
11.	Provision of instrumentation during and after accidents (accident and post-accident monitoring system)	(18)	[1], [2]	2017/2017 ongoing	2016/2017 ongoing	2015/2016 ongoing
12.	Development, technical justification, validation and implementation of symptom-oriented EOPs for management of design-basis and beyond design-basis accidents (low power and shutdown states)	(19), (23)	[1], [2]	completed/2015 ongoing	completed/2015 ongoing	completed/2015 ongoing
13.	Detailed analysis of primary system makeup in case of loss of power and/or ultimate heat sink	(20)	[1], [5]	2015 ongoing	2015 ongoing	2015 ongoing
14.	Replacement of self-contained air conditioners by those qualified for harsh environments and seismic impacts	(22)	[1], [2]	2015 ongoing/completed	2016/2017 ongoing	completed/2016 ongoing
15.	Habitability of MCR and ECR in design-basis and beyond design-basis accidents (installation of iodine filters)	(22)	[1], [2]	completed	–	–
Severe Accident Management						
16.	Severe accident analysis. SAMG development	(39), (41)	[1], [2]	2015/2016 ongoing	2015/2016 ongoing	2015/2016 ongoing
17.	Prevention of early containment bypassing in case of spread of molten corium to the containment	(31), (32)	[1], [2], [5]	–	2016/2017 ongoing	completed
18.	Implementation of a containment hydrogen control system for beyond design-basis accidents	(31), (32), (41), (11)	[1], [2]	completed	2016/2017 ongoing	completed/2016 ongoing
19.	Development and implementation of hydrogen mitigation measures for beyond design-basis accidents	(31), (32), (41)	[1], [2]	2017/2017 ongoing	2016/2017 ongoing	completed
20.	Implementation of a containment venting system	(31), (32), (41)	[1], [2]	2017/2017 ongoing	2016/2017 ongoing	2015/2016 ongoing

No	Measure / activity	Recommendations at European level	Recommendations at national level	Schedule/Status		
				¹ WWER-440/213	² WWER-1000/320	³ WWER-1000/302, 338
21.	Analysis of the strategy for possible corium confinement within the reactor pressure vessel	(31), (32)	[1], [5]	2016 ongoing	2015 ongoing	2015 ongoing
22.	Analysis of the need and possibility to qualify power unit components that may be involved in severe accident management for harsh environments	(31), (32), (33)	[1], [5]	2015 ongoing	2015 ongoing	2015 ongoing
23.	Detailed analysis and development of conceptual decisions on management with large volumes of contaminated water	(42)		2016 ongoing	2016 ongoing	2016 ongoing
24.	Seismic evaluation of buildings and systems of the on-site emergency center and their robustness in severe accident conditions	(43), (44)		SUNPP - completed ZNPP, RNPP, KhNPP - 2017/planned		
25.	Analysis of severe accident phenomena based on available experimental data and improvement of computer models	(44)	(5)	2017 planned	2017 planned	2017 planned
Additional Topics and Activities						
26.	Harmonization of Ukrainian nuclear and radiation safety regulations with WENRA reference levels: a) self-assessment; b) development of a harmonization action plan	(31)		completed		
27.	Self-assessment of the nuclear safety regulation system using the new IAEA instrument – SARIS	(103)		2015 ongoing		
28.	Provision of mobile laboratories to ZNPP and SUNPP	(110)		2016/2017 ongoing		
29.	Development of the concept and plan for the unified state automated radiation monitoring system of Ukraine (UARMS)	(110), (114), (120)		2016/2017 ongoing		
30.	Long-term (more than 24 hours) emergency training for all response parties, including central executive authorities, to test the knowledge transfer procedure in conditions of shift work of emergency staff	(113)		2016 ongoing		
31.	Implementation of the RODOS system	(115)		2015 ongoing		
32.	Modernization of the SNRIU Emergency Response and Information Centre	(121)		2015 ongoing		

Table 1.2 Measures Identified upon stress test at Chornobyl NPP

No	Measure / activity	Recommendations at European level	Recommendations at national level	Status	Schedule
1.	Installation of an additional level control device in 1 (2) fuel assembly cooling pools-1, 2 for emergencies related to level water decrease below marks 19, 22	(18)	[3], [4]	completed	2012
2.	Calculation analysis of buildings of nuclear safety category 1 to determine safety margins and potential failures under loads induced by a tornado of class F 3.0	(13)	[3], [4]	ongoing	2015
3.	Calculation analysis of buildings of nuclear safety category 1 to determine safety margins and potential failures under seismic loads	(13)	[3], [4]	completed	2015
4.	Seismic resistance analysis of ISF-1 SFP lining	(23), (30)	[3], [4]	completed	2015
5.	Analysis of stability and potential failures of VS-1 under SSE and tornado	(23), (30)	[3], [4]	completed	2014
6.	Nuclear safety justification for the spent fuel pools of units 1, 2 with 250×110 mm arrangement of SFAs (as reserve for one ISF-1 compartment)	(23), (30)	[3], [4]	completed	2012
7.	Justifying calculation of the maximum fuel cladding temperature taking into account potential radiological consequences from wet SFA storage	(23), (30)	[3], [4]	completed	2013
8.	Development of an action plan to improve the emergency preparedness system in case of beyond design-basis accidents caused by natural hazards, including emergency response measures in case of damage of the building and leakage of SFP	(26), (28), (34), (38), (39)	[3], [4]	completed	2012
9.	Amendment of the ChNPP accident and emergency response plan (32P-S) to improve emergency preparedness	(26), (28), (34), (37), (39)	[3], [4]	completed	2012
10.	Development of measures on prompt access of emergency teams from Slavutych by alternative routes in case of damage of Slavutych–ChNPP railroad tracks caused by SSE	(34)	[3], [4]	completed	2012
11.	Modernization of the ISF-1 radiation monitoring system to ensure neutron flux density monitoring	(18), (30)	[3], [4]	completed	2012
12.	Additional radiation monitoring of exposure dose rate of the container car in ISF-1 during spent fuel transportation	(18)	[3], [4]	completed	2012
13.	Replacement of the UDZhG-04R detector with an RWM-02 detector for the instrumentation channel for monitoring the activity concentration of service water after heat exchangers in ISF-1 spent fuel pools	(18)	[3], [4]	completed	2013
14.	Power supply to ISF-1 essential equipment fed from mobile DG	(15), (16), (26)	[3], [4]	completed	-
15.	Purchase of a new container car for SFA transportation	(30)	[3], [4]	ongoing	2015

No	Measure / activity	Recommendations at European level	Recommendations at national level	Status	Schedule
16.	Revision of the ISF-1 safety improvement plan	(23), (30)	[3], [4]	completed	2012
17.	Introduction of the topic “multiple failures of regular systems and equipment in severe weather conditions” into the 2012 training program for ChNPP staff of certain positions for detailed theoretical elaboration of the training scenario	(26), (28), (34), (108)	[3], [4]	completed	2012
18.	Introduction of the topic “multiple failures of regular systems and equipment in severe weather conditions” into the 2012 training program (Section 14) for practical exercise by staff of all shifts	(26), (28), (34), (108)	[3], [4]	completed	2012
19.	Psychological training of staff intended to increase resilience to psychological stress, develop self-control, composure and promote mutual aid and cooperation	(38), (122)	[3], [4]	completed	2012
20.	Implementation of a system for psychological selection and training of individuals involved in severe accident management, similar to the system for selection of operating personnel	(38)	[3], [4]	completed	2012

References

1. Comprehensive (Integrated) Safety Improvement Program (C(I)SIP), approved by Cabinet Resolution No. 1270 dated 7 December 2011.
2. SNRIU Board Resolution No. 13 dated 24-25 November 2011 “On results of the targeted safety reassessment of operating NPPs and ZNPP dry spent fuel storage facility in the light of the events at Fukushima-1”.
3. SNRIU Board Resolution No. 12 dated 3 November 2011 “On result of the targeted safety reassessment of Chornobyl NPP units 1-3 and Interim Spent Nuclear Fuel Storage Facility in the light of the events at Fukushima-1”.
4. Safety Improvement Plan for ChNPP Nuclear Installations.
5. SNRIU Board Resolution No. 14 dated 20 November 2012 “On the progress in implementation of measures based on stress-tests results for operating NPPs”.

Part II. Status of Safety Improvement Measures

Section 1. Status of Measures Identified upon stress test at Operating NPPs

This Section provides information on the status of measures identified upon stress tests at operating NPPs and presented in Table 1.1 of Part IV “Plan for Implementation of Safety Improvements” of the National Action Plan upon Stress-Test Results (2013).

Area: Natural Hazards

Item 1. Equipment qualification (harsh environments and seismic impacts)*

This measure is intended to confirm the operability of NPP systems and components and their capability to perform safety functions under seismic events and harsh environments (high temperature, pressure, radiation, moisture etc.) that may occur in design-basis accidents. Nonqualified equipment has to be replaced or necessary compensatory measures are to be implemented.

The input data for equipment qualification for all NPP units have been agreed by the SNRIU.

SUNPP-1: measure has been completed.

SUNPP-2,3, ZNPP-1,2: qualification for harsh environments has been completed; current status of seismic qualification has been evaluated, actions to increase seismic qualification are underway.

RNPP-1,2,4: qualification for harsh environments has been completed; current status of seismic qualification and actions to increase seismic qualification are underway.

RNPP-3: current status of qualification for harsh environments has been evaluated, actions to increase qualification are underway; current status of seismic qualification is under evaluation.

ZNPP-3-6: current status of qualification for harsh environments is under evaluation.

KhNPP-1,2: current status of equipment qualification for harsh environments and seismic events has been evaluated; actions to increase seismic qualification are underway.

Schedule: ZNPP-1,2 – 2015; SUNPP-2, ZNPP-3,4 and RNPP-1-4 – 2016; other power units – 2017.

Item 2. Seismic resistance of structures, systems and components important to safety

This measure is intended to ensure resistance to earthquakes of at least 7 magnitudes on the MSK-64 scale (but not less than 0.1 g peak ground acceleration) for equipment, piping, buildings and structures required to perform critical safety functions (provide for safe reactor shutdown and keep the reactor in safe state, remove heat from the reactor core and spent fuel pool, prevent radioactive releases to the environment).

The input data for assessing the seismic resistance of equipment, piping, buildings and structures of all NPP units have been agreed by the SNRIU.

SUNPP-1: measure has been completed.

SUNPP-2,3: seismic resistance of equipment, piping, buildings and structures has been evaluated, compensatory measures (replacement, reinforcement) are underway.

RNPP-1-4: seismic resistance of buildings and structures has been evaluated, seismic resistance of equipment and piping is under evaluation.

ZNPP-1-6, KhNPP-1-2: seismic resistance of equipment, piping, buildings and structures is under evaluation.

Schedule: ZNPP-1 – 2015; SUNPP-2 – 2015; ZNPP-2 – 2016; other WWER-1000 units and RNPP-1,2 – 2017.

Item 3. Consideration of a full range of initiating events for all reactor and SFP states in PSA

This measure is intended to perform probabilistic safety assessments of levels 1 and 2 for a full range of initiating events (including natural hazards) for all regulated states of the power unit, covering both the reactor core and spent fuel pool.

SUNPP-1: measure has been completed.

SUNPP-2, ZNPP-1,2, RNPP-3,4, KhNPP-2: activities implemented by the operating organization (except for seismic events) are under SNRIU review or revision upon review results; PSA for seismic events for ZNPP-1 is under development.

Schedule: SUNPP-2 – 2016; other power units – 2017.

Item 4. Implementation of a seismic monitoring system at NPP sites

This measure is intended to implement systems for continuous seismic monitoring in order to determine actual seismic characteristics of NPP sites. The monitoring results and numerical parameters for predicted seismic events will be used to plot new accelerograms and obtain ground response spectra for the design-basis earthquake (DBE) and safe shutdown earthquake (SSE).

SUNPP site: measure has been completed (on-site seismic monitoring system was commissioned in 2012).

ZNPP, RNPP and KhNPP sites: seismological monitoring systems have been designed and technical specifications for seismological monitoring equipment have been developed, actions to commission systems for seismological data recording and processing are underway.

Area: Loss of Safety Systems (Loss of Power and/or Ultimate Heat Sink)

Item 5. SFP makeup and cooling in long-term station blackout conditions

This measure is intended to ensure SFP emergency makeup through a series of actions to connect a mobile pumping unit to restore forced water circulation in SFP with boric acid solution from the system of tanks and emergency makeup of SFP from on-site water supply sources. It is needed to:

- perform calculations to justify characteristics of the mobile pumping unit (MPU) to ensure SFP makeup during the time required to restore design-basis systems;
- supply equipment;
- install special-type connectors to enable connection of MPU hydrants to on-site water supply sources and pressure piping of the SFP cooldown system and/or piping of emergency SFP makeup from the spray system;
- develop and introduce emergency procedures for use and connection of MPUs.

The concept for implementation of this measure for all power unit designs has been developed by the operating organization and agreed by the SNRIU; pilot power units are RNPP-2, SUNPP-1 and ZNPP-1.

SUNPP-1: measure has been completed (HRC-110 pumping station was purchased, necessary installation actions were taken, operating documentation was amended, testing was performed, procedure for SFP makeup from MPU was introduced, personnel were trained).

SUNPP-2: appropriate installation actions were taken, operating documentation was amended, procedure for SFP makeup from MPU was developed, actions on equipment purchase are underway.

RNPP-2 and ZNPP-1: technical requirements for equipment supply have been developed and agreed with the SNRIU.

Schedule: SUNPP-2 – 2015; RNPP-2, ZNPP-1,2 – 2016; other power units – 2017.

Item 6. SG makeup and cooling in long-term station blackout conditions

This measure is intended to connect mobile units to supply feedwater to SG and requires to:

- analyze potential water discharge to SG from turbine compartment deaerators at the maximum flow rate in long-term station blackout conditions;
- take actions to connect the emergency MPU for emergency SG makeup from on-site water sources, including:
 - calculations to justify characteristics of the MPU;
 - installation of special-type connectors to enable connection of MPU to any on-site water source and to the pressure side of the SG emergency makeup system;
 - development and implementation of emergency procedures for use of MPU for SG makeup and emergency heat removal from the core through SG.

The potential for recriticality and coolant leak through the main coolant pump sealing shall be taken into account in implementation of the measure.

The concept for implementation of this measure for all power unit designs has been developed by the operating organization and agreed by the SNRIU; pilot power units are RNPP-2, SUNPP-1 and ZNPP-1.

SUNPP-1: final stage of implementation (HRC-110 pumping station was purchased, necessary installation actions were taken, operating documentation was amended, testing was performed, procedure for SFP makeup from MPU was developed, personnel were trained, amendments to the emergency operating procedure for the power unit are being prepared).

SUNPP-2: necessary installation actions have been taken, actions to purchase equipment are underway (measure is implemented taking into account relevant experience at SUNPP-1).

RNPP-2 and ZNPP-1: technical requirements for equipment supply have been developed and agreed with the SNRIU.

Schedule: SUNPP-1 – 2015; SUNPP-2, RNPP-2, ZNPP-1,2, KhNPP-1 - 2016; other power units – 2017.

Item 7. Improved reliability of emergency power supply (SUNPP-1,2)

Item 8. Emergency power supply in long-term loss of power (other power units)

This measure is intended to take a series of actions to connect a mobile diesel generator to recover power supply to systems that can be used to inject water to the primary side and spent fuel pools, as well as to monitor and perform critical safety functions, ensure remote control of valves and emergency lighting, including:

- calculations to justify characteristics of the mobile diesel generator;
- connection of the mobile diesel generator to buses of the emergency power supply system of category 1 to energize design-basis pumps for high-pressure emergency boron injection, SFP cooldown pumps, uninterruptible power supply sources and systems required for monitoring of emergency processes;
- development and implementation of emergency procedures for use of the mobile diesel generator.

The concept for implementation of this measure for all power unit designs has been developed by the operating organization and agreed by the SNRIU; pilot power units are RNPP-2, SUNPP-1 and ZNPP-1.

SUNPP-1: measure has been completed (MDG-0.4 kV diesel generator unit was purchased and is located on a special truck platform including: 800 kW diesel generator, distribution cabinet with feeder breakers, 0.4/0.23 kV distribution transformers for 200 kVA and power cables; a special site for MDG was arranged; connection places were determined; operating documentation for MDG-0.4 kV was developed and existing documentation was amended; testing was performed).

SUNPP-2: final stage of implementation, actions to purchase equipment are underway (measure is implemented taking into account relevant experience at SUNPP-1).

Schedule: RNPP-2, ZNPP-1-3,5, RNPP-3, KhNPP-1 - 2016; other power units – 2017.

Item 9. Functionality of group A equipment fed from the service water system in case of water discharge in spray ponds

This measure is intended to take a series of actions for emergency supply of service water to essential loads by a mobile pumping unit from the NPP circulation water cooling system or other available water sources including:

- determination of an optimal list of loads that require emergency supply of service water from the mobile pumping unit (MPU);
- calculation to justify MPU characteristics to ensure water supply within the period required to restore operation of design-basis systems;
- equipment supply;
- development and implementation of emergency procedures for MPU use and connection.

The concept for implementation of this measure for WWER-440/213 and WWER-100/320 units has been developed by the operating organization and agreed by the SNRIU; pilot power units are RNPP-2 and ZNPP-1. Technical requirements for equipment supply have been developed and agreed with the SNRIU. Schedule: RNPP-2, ZNPP-1-3,5, RNPP-3, KhNPP-1 - 2016; other WWER-440/213 and WWER-100/320 power units – 2017.

This measure is not envisaged for SUNPP units 1, 2 (WWER-1000/302, 338) since their design includes ventilation cooling towers instead of spray ponds.

Item 10. Functionality of group A equipment fed from the service water system in case of failure of ventilation cooling towers and/or service water supply pumps

This measure is intended to take a series of actions to provide cooling water to standby DGs, equipment and mechanisms needed for reactor cooldown in loss of normal power supply buses and failure of essential service water supply system.

The concept for implementation of this measure for WWER-1000/302, 338 has been developed by the operating organization and agreed by the SNRIU. The pilot power unit is SUNPP-1.

SUNPP-1: measure has been completed (HRC-110 pumping station was purchased, necessary installation actions were taken, operating documentation was amended, testing was performed, procedure for alternative water supply from MPU to essential loads (with water intake from two possible sources: water intake pools of ventilation cooling towers or off-take/intake recirculation water channel of the Tashlyk reservoir) was developed, personnel were trained).

Schedule: SUNPP-2 – 2016 (measure is implemented taking into account relevant experience at SUNPP-1).

Item 11. Provision of instrumentation during and after accidents (accident and post-accident monitoring system)

This measure is intended to:

- install features to monitor coolant overheating at fuel assembly outlet, under the reactor head assembly and in hot legs of reactor coolant piping within an extended temperature range, including overheating modes;
- introduce features to monitor coolant level above the core in emergencies;
- install features to monitor hydrogen concentration in the containment during accidents;
- conduct additional research to determine the minimum required list of signals for accident and post-accident reactor monitoring;
- introduce emergency instrumentation with an extended measurement range for monitored process parameters;
- introduce a data storage system for conditions of design-basis and beyond design-basis accidents (black box).

RNPP-1,2 (WWER-440): The concept for implementation of this measure has been developed by the operating organization and agreed by the SNRIU, technical requirements for equipment supply are under development. Schedule: 2017.

WWER-1000 power units: The concept for implementation of this measure has been developed by the operating organization and agreed by the SNRIU; SUNPP-1 and ZNPP-1 are pilot units. Technical requirements for equipment supply have been developed and agreed with the SNRIU.

The first stage (installation of upper-level software and hardware for PAMS, introduction of a coolant level control system, link with software and hardware for design-basis instrumentation and connection with related systems) has been completed at SUNPP-1 (2012) and ZNPP-1 (2014).

Schedule: SUNPP-1 - 2015; SUNPP-2, ZNPP-1,2 - 2016; other power units – 2017.

Item 12. Development, technical justification, validation and implementation of symptom-oriented EOPs for management of design-basis and beyond design-basis accidents (low power and shutdown states)

Symptom-based EOPs for low power and shutdown states have been developed and implemented for the pilot power units (RNPP-1, SUNPP-1 and ZNPP-1).

The procedures for other power units have been developed and are being revised to incorporate SNRIU review comments. Schedule for implementation: 2015.

Item 13. Detailed analysis of primary system makeup in case of loss of power and/or ultimate heat sink

This measure is intended to carry out a detailed and comprehensive analysis of the need for makeup of the primary system in case of accidents involving loss of power supply and/or ultimate heat sink. The analysis is to address potential accident progression scenarios in which loss of power and cooling water will make primary system makeup impossible. Hence, the use of mobile sources for primary system makeup shall be considered as a

compensatory measure. Upon results of the analysis, additional measures for primary system makeup shall be revised as appropriate and additional technical features shall be determined.

Contracts have been concluded for detailed analysis of the need for primary system makeup for pilot power units (RNPP-1, SUNPP-1 and ZNPP-1) in case of accidents involving loss of power and/or ultimate heat sink. Schedule for submission of analysis results to the SNRIU: 2015.

Item 14. Replacement of self-contained air conditioners by those qualified for harsh environments and seismic impacts

KhNPP-1,2 and RNPP-4: measure was completed long before approval of the National Action Plan (as part of post-commissioning measures for KhNPP-2 and RNPP-4).

RNPP-2, SUNPP-1: measure has been completed.

RNPP-1: commissioning of new conditioners is underway.

ZNPP-1: technical specifications for equipment supply have been developed and approved.

Schedule: RNPP-1 - 2015; SUNPP-2, ZNPP-1,2 - 2016; other power units – 2017.

Item 15. Habitability of MCR and ECR in design-basis and beyond design-basis accidents (installation of iodine filters)

This measure was intended only for WWER-440/213 power units.

The measure has been completed (2011 – RNPP-1; 2012 – RNPP-2).

Area: Severe Accident Management

Item 16. Severe accident analysis. SAMG development

This measure is intended to develop severe accident management guidelines for operation at rated power as well as for low power and shutdown states. The guidelines shall be aimed at severe accident management both in the reactor core and spent fuel pool.

SAMGs for operation at rated power. SAMGs for pilot units (RNPP-1, SUNPP-1 and ZNPP-1) have been developed and introduced. The guidelines for other power units have been developed and are being revised to incorporate SNRIU review comments. Schedule for implementation: 2015.

SAMGs for low power and shutdown states. SAMGs for SFP. The SAMGs developed for pilot power units (RNPP-1, SUNPP-1 and ZNPP-1) are being revised to incorporate SNRIU review comments. Schedule for implementation: RNPP-1, SUNPP-1 and ZNPP-1 – 2015; other power units - 2016.

Item 17. Prevention of early containment bypassing in case of spread of molten corium to the containment

SUNPP-1,2: measure has been completed (appropriate analytical justifications were developed, enclosing concrete structure was installed on the way of potential corium spread, operating documentation was amended, in particular, regarding the position of doors in the lower part of the reactor concrete vault and in the room for reactor pressure vessel inspection during operation (closed doors are needed for shielding but they must not be locked to hinder spreading of the main corium part in case of an accident).

WWER-1000/320 power units: the concept for implementation of this measure at WWER-1000/320 reactors has been developed, ZNPP-1 is the pilot unit.

Schedule: ZNPP-1,2 - 2016; other WWER-1000/320 units – 2017.

Item 18. Implementation of a containment hydrogen control system for beyond design-basis accidents

This measure is intended to implement a hydrogen control system in the containment to ensure continuous monitoring and recording of hydrogen concentration (including post-accident period), which shall comply with qualification requirements for operation during design-basis and beyond design-basis accidents with loss of primary coolant and under seismic events.

SUNPP-1 and RNPP-1,2: measure has been completed (system was installed, operating documentation was amended, operating procedure for the system was developed, personnel were trained).
Schedule: SUNPP-2 and ZNPP-1 – 2016; other power units – 2017.

Item 19. Development and implementation of hydrogen mitigation measures for beyond design-basis accidents

This measure is intended to install passive autocatalytic hydrogen recombiners in the containment for safe mitigation of hydrogen during design-basis and beyond design-basis accidents leading to severe core damage.

SUNPP-1: measure has been completed (qualitative and quantitative analysis of hydrogen generation and spread was carried out, the number and locations of PARs were justified, PARs were tested on factory site, PARs were installed at the power unit, operating documentation was amended).

SUNPP-2: measure has been completed (taking into account relevant experience at SUNPP-1).

Schedule: ZNPP-1 – 2016; other power units – 2017.

Item 20. Implementation of a containment venting system

This measure is intended to:

- develop and implement a technical decision on forced filtered containment venting;
- develop a procedure for emergency containment venting in case of a severe accident, amend severe accident management guidelines.

In development of system design, it is necessary to provide for:

- appropriate calculations to confirm the effectiveness of containment pressure decrease, effectiveness of filtration of the vented medium, taking into account the need to minimize radioactive contamination of the environment;
- capability of the system to remain operational in station blackout conditions.

The concept for implementation of this measure has been developed by the operating organization and agreed by the SNRIU, pilot power units are RNPP-1, SUNPP-1 and ZNPP-1.

SUNPP-1: first stage has been completed (analytical and technical justification was provided for 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, piping made of steel sheets was replaced by steel seamless piping, necessary installation work was performed). Second stage is underway (purchase of equipment for filtered venting).

ZNPP-1: technical specifications for equipment supply have been developed and approved.

Schedule: SUNPP-1 - 2015; SUNPP-2, ZNPP-1,2 - 2016; other power units – 2017.

Item 21. Analysis of the strategy for possible corium confinement within the reactor pressure vessel

This measure is intended to analyze the possibility to implement the strategy for corium confinement within the reactor pressure vessel during severe accidents. The analysis shall take into account:

- need to avoid the occurrence of criticality in the corium;
- need for additional measures to prevent early containment bypassing;
- experience and advances of design organizations in countries operating WWER NPPs.

RNPP-1,2 (WWER-440/213): a contract is going to be concluded with the Kyiv Research and Design Institute 'Energoprojekt' for R&D "Analysis of the Possibility to Implement the Strategy for Corium Confinement within WWER-440 Pressure Vessel".

WWER-1000/302, 338, 320: first stage of R&D is under completion. Schedule for completion under contract: 2015.

Item 22. Analysis of the need and possibility to qualify power unit components that may be involved in severe accident management for harsh environments

At the beginning of 2015, the operating organization completed analysis of the need and possibility to increase harsh environment qualification of power unit components (for pilot units: RNPP-1, SUNPP-1

and ZNPP-1) that may/must be involved in severe accident management. The analysis results are under SNRIU review.

Item 23. Detailed analysis and development of conceptual decisions on management with large volumes of contaminated water

The operating organization currently analyzes world experience in managing large volumes of radioactive water.

Item 24. Seismic evaluation of buildings and systems of the on-site emergency center and their robustness in severe accident conditions

SUNPP site: measure has been completed (seismic resistance at a level of 0.15g for structures of the central control room and 0.18g for the on-site emergency center is provided, habitability of the center in severe accident conditions is ensured).

ZNPP, RNPP and KhNPP sites: measure will be completed by 2017 (taking into account results of on-site seismic monitoring, see item 4).

Item 25. Analysis of severe accident phenomena based on available experimental data and improvement of computer models

The first stage of this measure is to develop the “Program for analysis of severe accident phenomena based on available experimental data and improvement of computer models” to identify further administrative and technical actions to:

- validate and improve computer models for analysis of severe accidents (including purchase of new up-to-date computer codes);
- analyze severe accident phenomena with a high degree of uncertainty and assumptions made in the development of severe accident management guidelines.

The Program has been developed by the operating organization and will be submitted to the SNRIU for review and agreement in the near future.

Additional Topics and Activities

Item 26. Harmonization of Ukrainian nuclear and radiation safety regulations with WENRA reference levels:

- a) self-assessment;
- b) development of a harmonization action plan

In order to implement this measure, the SNRIU completed self-assessment for compliance of national nuclear safety regulations with the WENRA Reactor Safety Reference Levels (2008) in December 2013. According to the self-assessment, it was established that out of the 295 WENRA reference levels in 18 safety areas, national regulations on NPP safety fully complied with 226 reference levels (77%), differences were justified for 28 reference levels (9%) and incompliance was revealed for 41 reference levels (14%).

Following the self-assessment, the “Action Plan for Harmonization of NPP Safety Requirements with WENRA Reactor Safety Reference Levels” was developed, considered and approved at the SNRIU Board meeting (27 February 2014). The SNRIU takes actions in accordance with this plan.

At the same time, the “WENRA Safety Reference Levels for Existing Reactors. Update in relation to lessons learned from TEPCO Fukushima Dai-Ichi accident” became effective at the end of 2014 and the SNRIU intends to carry out self-assessment for compliance with the updated reference levels along with WENRA member states.

Item 27. Self-assessment of the nuclear safety regulation system using the new IAEA instrument – SARIS

The first stage has been completed (to implement this measure and comply with SNRIU Order No. 146 dated 20 December 2013, persons responsible for specific self-assessment areas were identified and the

nuclear and radiation safety regulatory system was self-assessed using the SARIS instrument in 2014. The self-assessment results were summarized and verified and the self-assessment report was developed).

The second stage is underway: the self-assessment report is being analyzed and a relevant action plan is being developed.

Item 28. Provision of mobile laboratories to ZNPP and SUNPP

SUNPP site: two mobile radiological monitoring laboratories based on off-terrain vehicles were purchased and supplied in 2012; trial operation stage is underway.

ZNPP site: actions to purchase two mobile radiological monitoring laboratories based on off-terrain vehicles are underway.

Item 29. Development of the concept and plan for the unified state automated radiation monitoring system of Ukraine (UARMS)

This measure is implemented to comply with the Cabinet Resolution “On Approval of the Action Plan for Development of a Unified Automated Radiation Monitoring System by 2015” to ensure radiation safety and radiation monitoring based on automated collection, transfer and analysis of actual data on radiation situation on the territory of Ukraine as well as to predict the development of radiation situation to support activities of state authorities at all levels and assess transboundary transfer of radioactivity inside and outside the country.

The SNRIU considered and agreed a decision on concept for the state program to create UARMS. To implement this decision, the above-mentioned Cabinet Resolution is to be amended. The draft Cabinet Resolution “On Approval of the Concept of State Target Scientific and Technical Program for Creation of a Unified State Automated Radiation Monitoring System in Ukraine by 2020 and Cancellation of Cabinet Resolution No. 44-r dated 25 January 2012”, draft explanatory note and the Concept itself are currently under review of relevant authorities.

Item 30. Long-term (more than 24 hours) emergency training for all response parties, including central executive authorities, to test the knowledge transfer procedure in conditions of shift work of emergency staff

Schedule: 2016.

Common plant training on the Rivne NPP site was conducted on 5–6 November 2014 on the scenario “a general accident caused by an extreme meteorological situation in the NPP location area that resulted in failure of the NPP main and emergency power supply sources and failure of nuclear reactor cooling systems” with complete activation of the SNRIU Information and Emergency Center. The training involved information exchange with the IAEA using the IAEA Unified System for Information Exchange on Incidents and Emergencies (USIE).

Item 31. Implementation of the RODOS system

In 2013, the RODOS decision support system for management of off-site emergencies was implemented at the SNRIU Information and Emergency Center. The RODOS systems have been introduced for RNPP and ZNPP regions using on-site radiation monitoring data and region-specific weather forecasts. The RODOS system is now under trial operation: updating of data from automated radiation monitoring systems and meteorological data is verified on a daily basis and the system is tested during emergency training of the SNRIU Information and Emergency Center. Data of the RODOS system were used in the common plant emergency training at RNPP on 5-6 November 2014 and IAEA international ConvEx 2d exercise on 25 November 2014.

Implementation of the RODOS system at Energoatom and State Emergency Service of Ukraine with its subsequent adaptation for SUNPP and KhNPP is to be completed in 2015, and then the RODOS systems for KhNPP and SUNPP will be installed at the SNRIU Information and Emergency Center.

Pursuant to recommendations of the NATO advisory support team to improve physical protection of critical nuclear facilities that worked in Ukraine from 4 to 9 May 2014, the SNRIU prepared and sent a

number of project proposals to the Mission of Ukraine to NATO, related directly to NATO recommendations for the regulatory authority in support of the governmental agencies of Ukraine for creating a unified automated radiation monitoring system and its integration into the RODOS system.

Item 32. Modernization of the SNRIU Emergency Response and Information Centre

Pursuant to recommendations of the NATO advisory support team to improve physical protection of critical nuclear facilities that worked in Ukraine from 4 to 9 May 2014, the SNRIU prepared and sent a number of project proposals to the Mission of Ukraine to NATO, related directly to NATO recommendations for the regulatory authority regarding improvement of the SNRIU emergency response system through:

- re-equipment of the Information and Emergency Center to provide modern communication and security means in order to ensure operation of systems for monitoring of security during radioactive material transportation and security of radioactive material management facilities and radiation sources;
- establish a backup emergency center.

Section 2. Status of Measures Identified upon stress test at Chornobyl NPP

This Section provides information on the status of measures identified upon stress tests at Chornobyl NPP and presented in Table 1.2 of Part IV “Plan for Implementation of Safety Improvements” of the National Action Plan upon Stress-Test Results (2013).

All undamaged spent nuclear fuel of the Chornobyl NPP is currently placed in the SFP of the interim spent fuel storage facility (ISF-1). Transportation of the damaged spent fuel from the SFPs of units 1 and 2 is planned for 2015. Therefore, the main efforts of the operating organization are focused on implementation of safety improvement measures at ISF-1.

Item 1. Installation of an additional level control device in 1 (2) fuel assembly cooling pools-1, 2 for emergencies related to level water decrease below marks 19, 22

Completed (in 2012)

Additional control of water level to prevent its potential emergency decrease is ensured in the spent fuel pools of units 1 and 2.

Item 2. Calculation analysis of buildings of nuclear safety category 1 to determine safety margins and potential failures under loads induced by a tornado of class F 3.0

It is planned to perform inspection of ISF-1 structures and appropriate calculations in 2015 to determine the safety margins and potential structural failures under a tornado of class F 3.0.

Item 3. Calculation analysis of buildings of nuclear safety category 1 to determine safety margins and potential failures under seismic loads

Completed (in 2013)

Calculations of ISF-1 structures related to nuclear safety category 1 testify that ISF-1 SFP civil structures can resist seismic events of 7 magnitudes (MSK-64 scale), while the safe shutdown earthquake for the ChNPP site is 6 magnitudes.

Item 4. Seismic resistance analysis of ISF-1 SFP lining

Completed (in 2013)

Calculations of ISF-1 SFP lining testify that it can resist seismic events of 7 magnitudes (MSK-64 scale), while the safe shutdown earthquake for the ChNPP site is 6 magnitudes.

Item 5. Analysis of stability and potential failures of VS-1 (ventilation stack for units 1 and 2) under SSE and tornado

Completed (in 2014)

Inspections and analyses of ventilation stack VS-1 testify that it can resist a seismic event of 6 magnitudes (safe shutdown earthquake) and a tornado of class F 1.5. Calculations show that VS-1 may fail under seismic events of 7 magnitudes and a tornado of class F 3.0. It should be noted that nuclear fuel is planned to be removed completely from units 1 and 2.

Item 6. Nuclear safety justification for the spent fuel pools of units 1, 2 with 250×110 mm arrangement of SFAs (as reserve for one ISF-1 compartment)

Completed (in 2012)

Nuclear safety justifications using the burnup credit approach for SFPs of units 1 and 2 allowed determining the arrangement of SFAs in SFPs of units 1 and 2 if emergency unloading of one of the ISF-1 SFP compartments is required.

Item 7. Justifying calculation of the maximum fuel cladding temperature taking into account potential radiological consequences from wet SFA storage

Completed (in 2013)

Additional analysis of fuel cladding cooling in ISF-1 storage conditions was carried out.

Item 8. Development of an action plan to improve the emergency preparedness system in case of beyond design-basis accidents caused by natural hazards, including emergency response measures in case of damage of the building and leakage of SFP

Completed (in 2012)

Emergency notification procedures and emergency response actions in case of potential structural collapse were improved.

Item 9. Amendment of the ChNPP accident and emergency response plan (32P-S) to improve emergency preparedness

Completed (in 2012)

Based on analysis of natural hazards, the ChNPP accident and emergency response plan was revised as appropriate.

Item 10. Development of measures on prompt access of emergency teams from Slavutych by alternative routes in case of damage of Slavutych–ChNPP railroad tracks caused by SSE

Completed (in 2012)

Procedure for delivery of emergency team personnel by motor vehicles from Slavutych to ChNPP (as alternative routes relative to railroad transportation) was developed and implemented.

Item 11. Modernization of the ISF-1 radiation monitoring system to ensure neutron flux density monitoring

Completed (in 2012)

Neutron flux density monitoring (within the radiation monitoring system) is envisaged for process rooms and areas for management and storage of spent nuclear fuel.

Item 12. Additional radiation monitoring of exposure dose rate of the container car in ISF-1 during spent fuel transportation

Completed (in 2012)

Additional detectors for monitoring of exposure dose rate were installed in the container car storage area in ISF-1 building.

Item 13. Replacement of the UDZhG-04R detector with an RWM-02 detector for the instrumentation channel for monitoring the activity concentration of service water after heat exchangers in ISF-1 spent fuel pools

Completed (in 2013)

Implementation of RWM-02 detector also provides for monitoring of radionuclide activity in service water supplied to ISF-1, thus allowing the contribution of ISF-1 to the total ChNPP discharges to be calculated.

Item 14. Power supply to ISF-1 essential equipment fed from mobile DG

Completed (in 2011)

The mobile DG is placed on the ChNPP site and can be connected to ISF-1 in-house power supply system.

Item 15. Purchase of a new container car for SFA transportation

Ongoing

A railroad container car has been delivered to ChNPP for transportation of packaging with spent nuclear fuel. The packaging is planned to be delivered in 2015 after factory acceptance testing.

The additional container car for SFA transportation will accelerate the removal of spent nuclear fuel from ISF-1 compartment in case of potential emergency leakage.

Item 16. Revision of the ISF-1 safety improvement plan

Completed (in 2012)

The ISF-1 safety improvement plan was revised to remove measures that had been already completed and analyzed in the ISF-1 safety analysis report.

Item 17. Introduction of the topic “multiple failures of regular systems and equipment in severe weather conditions” into the 2012 training program for ChNPP staff of certain positions for detailed theoretical elaboration of the training scenario

Completed (in 2012)

Item 18. Introduction of the topic “multiple failures of regular systems and equipment in severe weather conditions” into the 2012 training program (Section 14) for practical exercise by staff of all shifts

Completed (in 2012)

Item 19. Psychological training of staff intended to increase resilience to psychological stress, develop self-control, composure and promote mutual aid and cooperation

Completed (in 2012)

Training on the psychology of actions in extreme situations was introduced on a systematic basis for relevant groups of personnel.

Item 20. Implementation of a system for psychological selection and training of individuals involved in severe accident management, similar to the system for selection of operating personnel

Completed (in 2012)

Psychological examination of emergency team leaders is underway.

Annex. National Action Plan Upon Stress-test Results (2013)



National Action Plan



State Nuclear Regulatory Inspectorate of Ukraine

Kyiv
2013

INTRODUCTION

In June 2011, Ukraine joined the European initiative of conducting stress tests at nuclear power plants in EU member states and neighboring countries (Stress Test Declaration). The stress tests were performed at Ukrainian NPPs in compliance with the stress test specifications agreed by the European Commission and ENSREG (13 May 2011, Declaration of ENSREG, Annex 1: EU “Stress-Test” Specifications). The stress tests were focused on:

- Zaporizhzhya NPP units 1-6 (WWER-1000/320) and dry spent nuclear fuel storage facility (DSF) located on the Zaporizhzhya NPP site;
- Rivne NPP units 1, 2 (WWER-440/213) and units 3, 4 (WWER-1000/320);
- South Ukraine NPP unit 1 (WWER-1000/302), unit 2 (WWER-1000/338) and unit 3 (WWER-1000/320);
- Khmelnytsky NPP units 1, 2 (WWER-1000/320);
- Chornobyl NPP units 1-3 (spent fuel pools) and interim spent fuel storage facility (ISF-1) located on the Chornobyl NPP site.

The State Nuclear Regulatory Inspectorate of Ukraine (SNRIU) submitted the National Report developed in line with ENSREG recommendations to the EU Stress Test Secretariat on 30 December 2011 to be peer reviewed further.

According to the peer review procedure, the stress test results for Ukrainian NPPs were addressed in detail by European experts during topical reviews (January–February 2012) and by the peer review team that visited the SNRIU and South Ukraine NPP site in March 2012. ENSREG stated results from the peer review of stress tests for EU states and neighboring countries (Ukraine and Switzerland) in the summary peer review report and country specific reports on 26 April 2012.

The peer review country report for Ukraine concluded that the National Report of Ukraine complied with the ENSREG specifications, provided sufficient information to understand the design basis for external natural events, and identified adequate measures to compensate for safety deficiencies revealed. In addition, it was pointed out that previously planned NPP safety improvements (equipment qualification, NPP seismic resistance, long-term heat removal from the reactor core and spent fuel pool in case of station blackout and loss of the ultimate heat sink, severe accident analysis and development of severe accident management guidelines, etc.) should be completed.

The summary EC documents developed upon the peer review of stress tests and approved by the EC on 3 October 2012 set forth recommendations for the SNRIU to monitor in a systematic manner implementation of the measures identified upon stress tests by the operating organization. Along with recommendations for the SNRIU, the EC documents also outline good practices revealed in the peer review process.

In order to monitor the implementation of safety improvements at Ukrainian NPPs identified in the stress test and peer review processes, the SNRIU Board convened on 20 November 2012 to hold an open meeting. The SNRIU Board identified additional safety improvements related to severe accident management to take into account peer review recommendations.

The National Action Plan has been developed to implement recommendations of the peer review of stress tests at Ukrainian NPPs and to ensure that the operating organizations take safety improvements identified upon stress tests and the SNRIU efficiently monitors this process.

The development of the National Action Plan was initiated by the official statement of the ENSREG's Chairperson of 15 January 2013. The National Action Plan has been prepared by the SNRIU to fulfill the order of the Vice Prime Minister of Ukraine, Yuri Boiko, of 26 January 2013.

Structure of the National Action Plan:

Introduction

Part I. ENSREG Recommendations and Suggestions

Section 1. Natural Hazards

Section 2. Loss of Safety Systems

Section 3. Severe Accident Management

Part II. Key Topics of the Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS EOM)

Section 4. National Organizations

Section 5. Emergency Preparedness and Response

Section 6. International Cooperation

Part III. Additional Topics and Activities

Part IV. Plan for Implementation of Safety Improvements

Part I deals with consideration of the main ENSREG recommendations and suggestions provided in the document "Compilation of Recommendations and Suggestions. Peer Review of Stress Tests Performed on European Nuclear Power Plants" and the topics addressed at the Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS EOM) such as natural hazards, loss of safety systems and severe accident management. The information is provided with reference to the status and schedule of the measures outlined in Part IV.

Part II addresses the key topics of the Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS EOM) such as national organizations, emergency preparedness and response and international cooperation, with reference to the status and schedule of the measures outlined in Part IV.

The ENSREG recommendations and suggestions and topics of CNS EOM (Parts I, II and IV of NAcP) are numbered in accordance with the ENSREG recommendations on the structure and contents of national actions plans ("National Action Plan (NACp) Guidance as directed within the ENSREG Stress test Action Plan" with annexes).

Part III "Additional Topics and Activities" provides Ukraine-specific information on planned NPP safety improvements in the light of the Fukushima-1 events following the outcomes of:

- stress tests at operating NPPs (ZNPP, RNPP, SUNPP, KhNPP) and DSF (ZNPP);
- stress tests at ChNPP units and ISF-1;
- state review of stress test results;
- peer review, as set forth in the following ENSREG and EC reports:
 - i) Peer review country report. Stress tests performed on European nuclear power plants. Ukraine.
 - ii) Commission staff working document. Technical summary on the implementation of comprehensive risk and safety assessments of nuclear power plants in the European Union. Accompanying the document. Communication from the Commission to the Council and the European Parliament on the comprehensive risk and safety assessments ("stress tests") of nuclear power plants in the European Union and related activities.

This part additionally includes information on improvement of Ukraine's regulatory and legal framework on nuclear and radiation safety (to address lessons learnt from the Fukushima accident, ensure harmonization with the WENRA reference levels).

Part IV outlines safety improvement measures for operating NPPs and Chornobyl NPP following the stress test results and taking into account recommendations of the peer review and identifies the current status and schedule of the measures.

ABBREVIATIONS

C(I)SIP	Comprehensive (Integrated) Safety Improvement Program for Ukrainian NPPs
ChNPP	Chornobyl Nuclear Power Plant
CNS EOM	Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety
DG	Diesel Generator
DSF	Dry Spent Fuel Storage Facility (Zaporizhzhya NPP)
EC	European Commission
ECR	Emergency Control Room
ENSREG	European Nuclear Safety Regulators Group
EOP	Emergency Operating Procedure
FSS	Full-Scope Simulator
IAEA	International Atomic Energy Agency
ISF-1	Wet Interim Spent Fuel Storage Facility (Chornobyl NPP)
KhNPP	Khmelnitsky Nuclear Power Plant
MCR	Main Control Room
NACp	National Action Plan
NPP	Nuclear Power Plant
PAMS	Accident and Post-Accident Monitoring System
PAR	Passive Autocatalytic Hydrogen Recombiner
PGA	Peak Ground Acceleration
PORV	Pilot-Operated Relief Valve
PSA	Probabilistic Safety Assessment
RNPP	Rivne Nuclear Power Plant
RPV	Reactor Pressure Vessel
SAM	Severe Accident Management
SAMG	Severe Accident Management Guideline
SBO	Station Blackout
SFA	Spent Fuel Assembly
SFP	Spent Fuel Pool
SG	Steam Generator
SNRIU	State Nuclear Regulatory Inspectorate of Ukraine
SUNPP	South Ukraine Nuclear Power Plant
WENRA	Western European Nuclear Regulators Association
WWER	Water-Cooled Water-Moderated Power Reactor
ZNPP	Zaporizhzhya Nuclear Power Plant

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Part I. ENSREG Recommendations and Suggestions

Section 1. Natural Hazards

Assessment Methods (5)

Deterministic methods are used to define safety margins relative to all natural hazards including severe weather conditions. Probabilistic safety analyses are developed to determine risk contributors resulting from external impacts and other initiating events, identify safety deficiencies and develop additional compensatory measures.

Seismic evaluations (seismic qualification) of equipment, piping, buildings and structures important to safety using deterministic methods to define the minimum peak ground acceleration $PGA=0.1g$ ($PGA=0.12g$ for SUNPP site) and seismic analyses within PSA for external events for all Ukrainian NPPs are carried out under the Comprehensive (Integrated) Safety Improvement Program approved by Cabinet Resolution No. 1270 dated 7 December 2011 (C(I)SIP).

Actions: paras. 1,2,3, Table 1.1

Hazard Frequency (6)

Seismic evaluation (seismic qualification) of equipment, piping, buildings and structures important to safety is carried out for the return frequency of $10E^{-4}$ 1/year for seismic impacts using deterministic methods and taking into account minimum peak ground acceleration $PGA=0.1g$ ($PGA=0.12g$ for SUNPP site).

Actions: paras. 1,2,3, Table 1.1

Secondary Effects of Earthquakes (7)

Detailed analyses of seismic impacts are envisaged within PSA for external hazards for Ukrainian NPPs. The analyses will include assessment of secondary effects that may be induced by seismic impacts (floods and fires).

Actions: para. 3, Table 1.1

Protected Volume Approach (8)

Flooding Margin Assessments (12)

External Hazard Margins (13)

External hazards were analyzed within the stress tests for Ukrainian NPPs. Potential flooding levels were analyzed and margins for all external hazards, including severe weather conditions, were assessed. The general approach used to confirm the existing margins is based on the adequate elevation of NPP sites and on the fact that equipment important to NPP safety is located in waterproof rooms. The outcomes of stress tests confirmed the adequacy of design safety margins relative to external hazards.

The impact of severe weather conditions is to be considered in more detail within periodic safety reviews of NPPs.

No provisions for supplementary actions

For margins relative to seismic impacts, the operating organization developed the document "Methodology for Analyzing the Seismic Resistance of Operating NPP Components within the Seismic Margin Assessment" (based on the Seismic Margin Assessment methodology recommended by IAEA publication NS-G-2.13). The Methodology is used to calculate the seismic margin of NPP structures, systems and components.

Seismic margins are also assessed using the "Methodology for Assessing the Seismic Resistance of Equipment for Seismic Qualification Purposes".

Actions: paras. 1,2, Table 1.1

Early Warning Notifications (9)

Ukraine has a notification system on deterioration of weather conditions. The operational service of the Hydrometeorological Centre, within the State Emergency Service of Ukraine, sends appropriate messages to predetermined recipients including NPPs, operating organizations, SNRIU Information and Emergency Response Centre.

Actions of NPP operating personnel in case of such messages are identified in appropriate procedures/orders.

No provisions for supplementary actions

Seismic Monitoring (10)

Permanent seismic monitoring systems are under implementation at ZNPP, RNPP and KhNPP. The permanent seismic monitoring system at SUNPP was introduced in 2012.

Actions: para. 4, Table 1.1

Qualified Walkdowns (11)

In the development of PSA-1 for all external hazards for Ukrainian NPPs, systematic walkdowns were performed at all sites and all power units. There were additional walkdowns at all power units and sites within the stress tests.

The SNRIU agreed the document "Methodology for Assessing the Seismic Resistance of Equipment for Seismic Qualification Purposes" for equipment qualification at Ukrainian NPPs using indirect methods, including NPP walkdowns and inspections. The methodology has been developed with due regard of IAEA approaches and recommendations and contains the main criteria for seismic verification of components subject to seismic qualification during NPP walkdowns.

Actions: paras. 1,2, Table 1.1

Section 2. Loss of Safety Systems (Loss of Power and/or Ultimate Heat Sink)

Alternative Cooling and Heat Sink (14)

Upon stress test results, approaches were developed for alternative cooling and heat removal at WWER-440 and WWER-1000 power units.

For WWER-1000, alternative makeup of SGs is planned with mobile pumping units from accessible water sources and through alternative use of regular systems (water discharge from turbine compartment deaerators).

For WWER-440, the additional emergency feedwater system (AEFS) introduced in 2010 may be used for alternative cooling (paras. 1.1.2 R and 7.1 of the National Report of Ukraine). The system is redundant to the existing SG makeup systems (main, auxiliary and emergency feedwater systems) and is protected against external impacts (including seismic impacts). A mobile pumping unit will be used to feed AEFS tanks in case of long-term SBO conditions.

Actions: paras. 5,6, Table 1.1

AC Power Supplies (15)

The stress tests included analysis of possible power supply of all NPPs from on-site and off-site sources (thermoelectric and hydroelectric power stations, outdoor switchgears, high-voltage lines, etc.) and appropriate connection programs.

To ensure power supply in case of extreme events that may cause long-term station blackout, separate mobile 0.4 kV and 6.0 kV diesel generators will be used to feed at least one emergency power distribution panel.

Actions: paras. 7,8, Table 1.1

DC Power Supplies (16)

The current emergency operating procedures for NPPs include actions on the increase of battery discharge time through transfer of some noncritical equipment from automatic to remote control operation.

In case of station blackout, 0.4 kV distribution boards connected to the 0.4 kV mobile diesel generator may be used to feed uninterruptible power supply units and DC boards and recharge batteries.

Actions: paras. 7,8, Table 1.1

Operational and Preparatory Actions (17)

Fuel reserve for 7 days is available at all NPP sites for each DG, and design unattended operation of DGs in emergencies is 250 h.

In case of failure or impossibility to use regular DGS, there are measures to provide NPP sites with mobile pumping units and diesel generators (see (14) and (15)). It is additionally planned to develop measures for their refueling if long-term performance is needed.

To deliver additional fuel and enable access of mobile units to connection points in case of potential damage on NPP sites caused by extreme events, the response plans and interaction procedures shall envisage a sufficient number of appropriate engineering machines to clear blocked access roads. The sufficiency of engineering machines in case of extensive infrastructure damage and routes is to be analyzed in SAMG development/revision.

Actions: paras. 5,6,7,8,9,10,16, Table 1.1

Instrumentation and Monitoring (18)

The C(I)SIP includes measures on emergency and post-accident monitoring of power unit parameters. Additional instrumentation (reactor coolant level, hydrogen concentration in the containment, etc.) is to be installed and existing instrumentation is to be improved (to extend the measuring range). An emergency and post-accident monitoring system is under implementation to provide operating personnel and engineering support team of the emergency management staff with necessary, sufficient and reliable data on critical safety functions and on effectiveness of protective barriers during and after design-basis and beyond design-basis accidents (including severe accidents) to be used to transfer the reactor into a controlled stable state and take mitigating measures identified in the emergency plan.

In addition, measures may be taken to monitor critical parameters in case of long-term station blackout (supply from mobile DGs).

Actions: paras. 11,7,8, Table 1.1

Shutdown Improvements (19)

To control accidents in reactor shutdown states, the C(I)SIP envisages development of additional emergency documentation for all NPPs – emergency operating procedures and severe accident management guidelines to cope with accidents that may occur at low power and shutdown states.

Actions: paras. 12,16, Table 1.1

Reactor Coolant Pump Seals (20)

The WWER-1000 reactor coolant pump seals perform their functions in case of station blackout during 24 hours (experimental data, bench tests, Saint Petersburg, Russia).

To take into account recommendations of the peer review of stress tests at Ukrainian NPPs, additional makeup of the primary system for longer blackout times is to be analyzed (considering other measures needed to manage SBO accidents).

Actions: para. 13, Table 1.1

Ventilation (21)

The detailed emergency protection strategy in the event of long-term station blackout envisages feeding of one safety system train (including support ventilation systems) from a 6 kV mobile DG.

Main and Emergency Control Rooms (22)

The C(I)SIP includes measures intended to improve the operability and habitability of the main and emergency control rooms (upgrading of the MCR and ECR air conditioning system – installation of air conditioners qualified for harsh environments and seismic impacts; iodine filters will be installed for WWER-440/213 units).

The measures planned to provide power supply from mobile DGs in case of station blackout additionally include development of a list of critical equipment, including that needed to ensure MCR and ECR habitability.

Actions: paras. 14,15,7,8, Table 1.1

Spent Fuel Pools (23)

In order to improve personnel actions in case of accidents with the spent fuel pool, emergency procedures and SAMGs for SFPs are under development and implementation.

Upon stress test results, additional measures are to be implemented to ensure SFP makeup from mobile pumping units at WWER-440 and WWER-1000 in case of station blackout.

Actions: paras. 5,12,16, Table 1.1

Separation and Independence (24)

In addition to design features based on the principles of independence and redundancy and use of passive and active systems, redundant means are envisaged for emergency makeup of SGs and SFPs and emergency power supply using mobile pumping units and diesel generators - see (14) (15) and (23).

Upon stress test results, measures have also been developed to ensure emergency water supply to critical equipment of group A using mobile pumping units.

Actions: paras. 5,6,7,8,9,10, Table 1.1

Flow Path and Access Availability (25)

The state of valves in case of blackout was analyzed and appropriate valve control actions were identified during preparation and implementation of symptom-oriented EOPs. Upon stress tests results, measures have been additionally developed to improve DC sources and ensure operability of critical valves in case of blackout (including valves with air actuators) – see (15) and (16).

Access to critical equipment in SBO conditions should be confirmed in validation of severe accident management guidelines.

Actions: paras. 7,8,12,16, Table 1.1

*Mobile Devices (26)**Bunkered/Hardened Systems (27)*

Upon stress test results, measures have been developed to use mobile diesel generators and pumping units for alternative emergency power supply, makeup of SGs and SFPs and supply of cooling service water to critical equipment. Places for storage, installation and connection to power unit systems, water sources, delivery routes and deployment time are determined individually for each power unit taking into account specific site features and potential hazards (increased seismic requirements).

Actions: paras. 5,6,7,8,9,10, Table 1.1

Multiple Accidents (28)

Upon stress tests results, measures have been developed to use mobile diesel generators and pumping units for alternative emergency power supply, makeup of SGs and SFPs and supply of cooling service water to critical equipment of each power unit. It is also envisaged to improve SAMGs to consider accidents occurring simultaneously on one site.

Actions: paras. 5,6,7,8,9,10,16, Table 1.1

Equipment Inspection and Training Programs (29)

In accordance with Ukrainian nuclear safety regulations, to modify structures, systems and components important to safety, it is needed to introduce appropriate changes into operating and emergency documentation; train personnel; develop testing programs, to be agreed with the SNRIU, both at the equipment fabrication plant and NPP for introduction in trial and commercial operation (participation of an SNRIU representative in the tests is obligatory).

The measures developed upon stress tests will be also subject to these requirements of Ukrainian nuclear safety regulations.

No provisions for supplementary actions

Further Studies to Address Uncertainties (30)

Additional studies are envisaged for the development of measures upon stress tests results:

– *Additional studies to check the integrity of the spent fuel pool in the event of boiling or external impact*

The spent fuel pool consists of a metal casing placed into reinforced-concrete enclosing structures to ensure its protection against external impacts. Personnel actions in case of accidents at SFPs are addressed in the development and justification of emergency operating procedures and SAMGs for SFPs.

– *Additional studies to confirm functionality of systems needed in station blackout*

The detailed emergency protection strategy in case of long-term SBO conditions envisages use of mobile DGs to ensure SFP makeup.

– *Additional studies to assess emergency actions in the event of widespread damage*

Factors that complicate severe accident management (infrastructure damage, simultaneous accidents at several power units and other industrial facilities, etc.) are to be analyzed in SAMG development/revision - see (34, 35).

Section 3. Severe Accident Management**WENRA Reference Levels (31)**

The SNRIU participates in WENRA activities as an observer since 2009. Along with IAEA standards and other international publications, WENRA documents are taken into account in the development of new regulations on nuclear and radiation safety. The SNRIU intends to perform self-assessment and develop a relevant action plan to harmonize national documents with the WENRA reference levels. Comprehensive harmonization with the WENRA reference levels is planned under Project INSC U3.01/10 with assistance of European consultants.

An annual plenary WENRA session is to take place in autumn 2013 in Ukraine.

Actions: para. 26, Table 1.1

- *Hydrogen control*

Passive autocatalytic hydrogen recombiners (PARs) are installed at RNPP-1,2 (V-213), RNPP-4 and KhNPP-2 (V-320) in the quantity sufficient for design-basis accidents. The C(I)SIP includes activities to install PARs to cope with the hydrogen generation rate and amount in severe accidents relative to the reactor core. It is also planned to consider hydrogen generated in SFPs. Conceptual technical decisions have been developed for all reactor types for hydrogen control in the containment.

Actions: para. 19, Table 1.1

- *Hydrogen monitoring system*

A hydrogen monitoring system is under implementation. To assess potential burning and/or explosion of hydrogen, three main parameters are to be monitored: concentration of hydrogen, oxygen and water vapors. Measured data are transferred to MCR/ECR and emergency centers within the post-accident monitoring system. These data are taken into account in selecting and implementing severe accident management strategies in accordance with SAMGs.

Actions: paras. 18,11, Table 1.1

- *Depressurization of reactor coolant system in severe accidents*

The reactor coolant system is depressurized in severe accidents by pressure relief through the pressurizer PORV. Pressurizer PORVs have been replaced at all NPP units by safety valves qualified for the feed & bleed mode. Appropriate actions are determined in severe accident management guidelines.

The operability of equipment for depressurization of the reactor coolant system is verified during qualification of equipment involved in severe accident management.

Actions: para. 22, Table 1.1

- *Containment overpressure protection*

Prior to stress tests, the SNRIU established the requirement to implement containment filtered venting systems at WWER-1000 units (para. 7.3 of the National Report of Ukraine). Conceptual technical decisions have been developed to analyze the potential use of existing design features and implement an individual system. The system is to remain operable in station blackout and safe in terms of hydrogen hazard; radiological consequences should be also taken into account in case of steam-gas dumping. The need to implement this system for WWER-440 is being assessed, taking into account specific design features of the power units.

Actions: para. 20, Table 1.1

- *Molten corium stabilization*

It is planned to take measures for molten corium stabilization at WWER-440 and WWER-1000 units; appropriate conceptual technical decisions have been developed. For WWER-440, the strategies are aimed at keeping the molten corium in the reactor pressure vessel, decisions on external RPV cooling are under consideration. For WWER-1000, the measures are aimed at keeping the molten corium within the containment; for example, placement of refractory material into channels of ionization chambers, corium spread in the reactor concrete shaft are considered.

Actions: paras. 17, 21, Table 1.1

SAM Hardware Provisions (32)

The following severe accident strategies are identified in the SAMG development process: primary makeup, primary system depressurization, SG makeup, SG pressure decrease, containment injection, hydrogen control in containment, containment venting, melt cooling.

To implement the strategies, additional systems are planned: PARs, containment venting system, means for keeping molten corium in the reactor pressure vessel and vault.

There are plans to qualify equipment involved in severe accident management in severe accident conditions.

Actions: paras. 17-22, Table 1.1

Review of SAM Provisions Following Severe External Events (33)

It is planned to qualify regular equipment involved in the severe accident management strategies for severe accident conditions and extreme impacts. New severe accident management systems include equipment that is to be operable in severe accident and external extreme conditions (seismic impacts).

Actions: paras. 22,1,2,5-11, Table 1.1

Enhancement of Severe Accident Management Guidelines (SAMG) (34, 35)

SAMGs will be revised on a permanent basis, first of all, in order to take into account specified characteristics of systems and equipment implemented for severe accident management. SAMG revision should include review of SAMG analytical and technical justification and additional effectiveness analysis of severe accident management strategies taking into account implemented measures.

SAMG Validation (35, 36)

SAMG validation is inseparable part of SAMG development and implementation (para. 16, Table 1.1). The SAMGs developed for the pilot units were validated with the table top method. To validate SAMGs, two working groups were set up at each NPP: from MCR personnel and engineering support team. The validation scenarios were selected so as to cover all severe accident management guidelines and consider different configurations of available equipment. After implementation of additional severe accident management measures, SAMG revalidation is planned to take into account changes made.

No provisions for supplementary actions

SAM Exercises (35, 37)

The National Nuclear Operator *Energoatom* develops and implements programs of emergency exercises to test personnel actions in emergencies. The programs are prepared so as to cover all elements of the NPP emergency plan and *Energoatom* emergency plan over a year. Common general plant emergency exercises are conducted every three years at NPPs, plant exercises once per year and emergency exercises of emergency groups and teams once per quarter. Extraordinary emergency exercises were conducted at all NPP sites to learn lessons from the Fukushima accident using natural hazard scenarios.

No provisions for supplementary actions

SAM Training (38)

There are training centers at NPPs that are provided with technical training means including full-scope simulators (FSS) needed for training, retraining and professional development of personnel. SAMG implementation envisages training of NPP personnel on severe accident management strategies, structure and actions in accordance with SAMG. Training involves personnel of the engineering support team, MCR operating staff and instructors of the training centre. In January 2013, the first stage of SAMG training was conducted at the SUNPP site for the engineering support team and training centre instructors.

It should be noted that the operating organization improves the full-scope simulators on a permanent basis in accordance with the utility FSS upgrading program for 2011–2015 (PM-D.0.06.344-10). Measures are currently underway to improve the FSS at SUNPP-3 (replacement of the main simulation computer, new technology for primary system simulation, 3D core model, simulation of severe accidents, etc.).

No provisions for supplementary actions

Extension of SAMGs to All Plant States (39)

SAMGs for full power were developed for all reactor designs (V-213, V-320 and V-302/338) in 2012. It is planned to develop SAMGs for low power and shutdown states and for SFPs. The SAMG development takes into account mutual impacts of the core and SFPs.

Actions: para. 16, Table 1.1

Improved Communications (40)

Dedicated communication is ensured between the NPP emergency centers, ECR, MCR, central control board, radiation safety monitoring boards and automated radiation monitoring systems. Radio communication is arranged to ensure reliable connection between the NPP

emergency centers and emergency groups and teams working in NPP rooms, on NPP site and off-site. NPPs ensure dedicated communication between the emergency centers and operating organization, state nuclear regulatory body, state nuclear energy management bodies, authorized bodies for emergencies and civil protection of population of the state administration in the region of NPP observation area, executive local bodies of populated centers near NPPs. The adequacy of communication means, including that in SBO conditions, is verified during emergency exercises.

The measure related to transfer of data to emergency centers in severe accident conditions is implemented within the introduction of the accident and post-accident monitoring system (PAMS).

Actions: para. 11, Table 1.1

Presence of Hydrogen in Unexpected Places (41)

Hydrogen safety issues were addressed within vulnerability assessment of NPPs in severe accident conditions and justification of severe accident management strategies, as well as during stress tests. Hydrogen generation in severe accident conditions may occur in the reactor and spent fuel pool. Hydrogen control measures take into account the amounts and dynamics of hydrogen generation in the reactor and spent fuel pool, considering severe accident management measures.

The severe accident management guidelines for different reactor states (including shutdown states with open containment) and for SFPs identify strategies to ensure hydrogen safety.

To implement the measure for containment filtered venting, actions are taken to prevent hydrogen burning and explosion in steam-gas dumping.

Actions: paras. 16, 18, 19, 20, Table 1.1

Large Volumes of Contaminated Water (42)

It is planned to analyze in detail and develop conceptual decisions on management of large volumes of contaminated water. To develop conceptual decisions, it is envisaged to assess potential volumes of contaminated water, analyze the capability of the evaporation system and the number of drums for evaporation bottoms and places of their storage (if necessary, additional reserve should be provided), evaluate the adequacy of water activity monitoring and measures for prevention of groundwater contamination, etc.

Actions: para. 23, Table 1.1

Radiation Protection (43)

Planning and implementation of emergency measures take into account potential doses and radioactive contamination on NPP site. A series of organizational and technical measures have been developed for radiation protection of personnel involved in accident management (personnel protection modes, timely implementation of countermeasures, radiation surveys, dose monitoring, provision of emergency personnel with preventive remedies, use of radiation protection means, etc.).

No provisions for supplementary actions

On-site Emergency Centre (44)

The on-site emergency centre is equipped with systems to ensure its habitability and functionality in normal operation and accidents, protection against radiological and chemical impacts, provision of ventilation and air conditioning, including SBO conditions (independent diesel generators). If the on-site emergency centre fails, there are off-site emergency centers for all NPPs.

Additional measures are envisaged to assess the seismic resistance of buildings and systems of the on-site emergency centre and its habitability in severe accidents.

Actions: para. 24, Table 1.1

Support to Local Operators (45)

Support to affected NPPs in severe accident management is part of the *Energoatom* emergency preparedness and response system. Appropriate actions are identified in the emergency response plan of *Energoatom* management and NPP emergency plans. The emergency response plan envisages support to the affected NPP through the use of the operating organization's resources, including resources of other NPPs and *Energoatom* separated enterprises such as the Emergency and Technical Centre and *AtomRemontService*. Staff and technical means are allocated to each NPP from the State Emergency Service, Ministry of Internal Affairs, Ministry of Defense and Ministry of Health of Ukraine, which are brought on site upon request of NPP management to provide support on site and in controlled area.

No provisions for supplementary actions

Level 2 Probabilistic Safety Assessments (PSAs)(46)

In 2005-2010, PSA-2 for full power for internal initiators relative to the reactor core was developed for all NPP units. PSA-2 for low power and shutdown states was additionally developed for ZNPP-5. PSA-2 has been developed for ZNPP-1 for all operating states, internal and external events, relative to the core and SFP. Efforts are currently underway to extend the scope of PSA-2 to all NPP units. In compliance with regulations, probabilistic assessments are combined with deterministic analyses.

Actions: para. 3, Table 1.1

Severe Accident Studies (47)

The vulnerability assessment of NPPs in severe accident conditions included analysis of the main phenomena of severe accidents and preliminary effectiveness evaluations of severe accident management strategies. It is planned to study phenomena of severe accidents based on available experimental data and data on the Fukushima accident, use new versions of computer codes and improve computer models and approaches to severe accident analysis considering recent international studies.

Actions: para. 25, Table 1.1

Part II. Key Topics of the Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS EOM)**Section 4. National Organizations**

Review and revision of nuclear laws, regulations and guides (101)

- *In case the regulatory body is constituted of more than one entity, it is important to ensure their efficient coordination*
- *Emphasize the need for comprehensive periodic safety reviews using state-of-the-art techniques*
- *Remind the Contracting Parties (CP) that national safety frameworks include the regulatory body, technical support organization and operating companies*
- *Wide participation of the operating companies, regulatory body and technical support organization in safety networks will strengthen them*

According to the Ukrainian legislation, the State Nuclear Regulatory Inspectorate of Ukraine is the sole state nuclear regulatory body.

To improve the institutional stability, efficiency and independence of the state nuclear regulatory body through formalizing its status of a state collegial executive body in law, the SNRIU has developed a draft Law of Ukraine "On National Commission for State Regulation of Safety in the Field of Nuclear Energy Use". The Verkhovna Rada of Ukraine approved the draft Law in principle (in the first reading) on 18 October 2011. The parliamentary committees of the Verkhovna Rada are now preparing the draft law for repeated review (second reading).

The State Nuclear Regulatory Inspectorate of Ukraine has two technical support organizations: the State Scientific and Technical Centre for Nuclear and Radiation Safety (SSTC NRS) and the State Centre for Quality Regulation of Supplies and Services (State Enterprise *DerzhCentrYakosti*).

The government appoints operating organizations (operators): the operator of all functioning nuclear power plants (NPPs) in Ukraine is the National Nuclear Operator *Energoatom* and of the Chornobyl NPP the State Specialized Enterprise "Chornobyl NPP".

The periodic safety review (every 10 years or on SNRIU request) is a legislative requirement of Ukraine. The use of updated assessment methods is a requirement of the SNRIU's regulatory documents.

Ukraine's international cooperation in the field of peaceful use of nuclear power and nuclear and radiation safety is a tool to meet the world standards of safe operation of nuclear power plants at all life stages by means of multilateral international agreements and treaties.

Multilateral international cooperation is effected through international organizations to which Ukraine is a Party, multilateral international agreements, treaties and conventions that Ukraine has executed or acceded to.

Since 1994, the SNRIU has been representing Ukraine on the WWER Regulators Forum. As a country operating NPPs with WWER reactors, Ukraine largely participates in annual meetings of the Heads of Regulatory Bodies and working group sessions established and functioning within the Forum to permit exchange of critical information and accumulated experience in the field of nuclear safety of WWER reactors and making joint decisions on safety-related issues.

In 2009 Ukraine entered the Western European Nuclear Regulators Association (WENRA) as an observer. SNRIU's representatives actively participate in plenary sessions of the Heads of the European Regulatory Bodies and meetings of working groups on experience exchange, and learning from the best international practices in the field of nuclear and radiation safety and harmonization of regulatory requirements for NPP safety.

In international institutions, Ukraine is also represented by the SSTC NRS, which has been actively involved in activities of the European Technical Support Organizations Network (ETSON) as an associated member since 2010.

At the operator's level, Ukraine is represented in the World Association of Nuclear Operators (WANO) by the National Nuclear Operator *Energoatom*.

Energoatom has been involved in the EUR (European Utility Requirement) activities – as an associated member since 2005 and as a full member since 2007, with the main task of the EUR being development of technical requirements for the design of new nuclear power plants with light-water reactors of generations III and III+ in view of continued development of nuclear power industry in Europe.

Actions: ensure continued active participation of Ukraine in international organizations by the regulator, the technical support organization and the operating organization.

Changes in functions and responsibilities of the regulatory body (102)

- *Effective independence of the regulatory body is essential, including the following aspects:*
 - *transparency in communicating its regulatory decisions to the public*
 - *competent and sufficient human resources*
 - *adequate legal powers (e.g. to suspend operation)*
 - *financial resources*

Independence of the regulatory body and its legal powers. According to Ukrainian legislation, the state nuclear regulatory body is independent of any other state bodies, agencies and public officers whose activities are related to the use of nuclear power, of local executive bodies and local governments, of any non-governmental organizations, and has respective legal powers (e.g. to impose financial sanctions upon enterprises, agencies, organizations and entrepreneurs; to limit, suspend or stop operation; impose liability on persons found to have violated law and nuclear and radiation safety requirements).

Transparency. The public is continuously informed of any regulatory decisions made through posting information on the public web-site of the SNRIU <http://www.snrc.gov.ua>, and is involved in public discussions of draft legal acts and in sessions of the SNRIU Board. There is a standing elective collegial and consultative body subordinated to the SNRIU – Public Council, which is established to ensure public involvement in the administration of state affairs, public oversight of the SNRIU's activities, establishment of efficient interaction between the SNRIU and the public, consideration of the public opinion in planning and implementation of the state policy in the field of nuclear energy use.

Staffing with competent personnel. As a result of the administrative reform of 2010, the SNRIU staff was reduced by 20%. The work experience under the reduced staff has demonstrated infeasibility to perform the functions and deliver assigned duties in the full scope without increasing the number of staff.

To restore the capabilities of the SNRIU as of the state nuclear regulatory body, a draft resolution of the Cabinet of Ministers of Ukraine was elaborated on the staff increase in the SNRIU. As of today, the draft resolution of the Cabinet of Ministers of Ukraine is under review by the bodies concerned. Approval of the mentioned Cabinet resolution will permit quantitative and qualitative improvement of the SNRIU staffing and adding to its competence.

Financial resources. The SNRIU is functioning under shortage of financial, technical and human resources. Every year, when a draft state budget for the coming year is being prepared, and repeatedly during the year, the SNRIU submits a budget request with all supporting calculations and substantiations of increased funding to allow successful performance of assigned duties and functions.

Importance of inviting IRRS missions (103), alongside with:

- *efficient implementation of their findings*
- *making the findings and the ways of their implementation publicly available*

- *invitation of follow-up missions*

The SNRIU extensively uses the IAEA IRRS mission as a tool to assess efficiency of the regulatory system for nuclear and radiation safety. In particular, Ukraine was among the first IAEA Member States to host a full-scope IRRS mission (June 2008). To ensure the mission recommendations and suggestions are taken into account adequately, the SNRIU in cooperation with other central executive bodies elaborated the "Action Plan for Implementation of Recommendations and Suggestions of the IAEA Integrated Regulatory Review Service (IRRS) Mission" (hereinafter referred to as the "Action Plan") approved by the Cabinet of Ministers of Ukraine, Resolution No. 1307-r dated 8 October 2008.

According to the specified Resolution of the Cabinet of Ministers of Ukraine, the SNRIU together with other central executive bodies shall systematically (on a biannual basis) report to the Government of Ukraine on the implementation status of each item of the Action Plan. The status of recommendations and suggestions of the IRRS mission is regularly reviewed at sessions of the SNRIU Board open to the public.

To review the efficiency of activities designed to address the IRRS recommendations, a follow-up IAEA mission was invited to Ukraine in November 2010 "Integrated Regulatory Review Service Follow-Up (IRRS follow-up)".

The next IRRS mission is scheduled for 2017-2018. Self-assessment of the nuclear and radiation safety regulation system using new IAEA tools (Self-Assessment of Regulatory Infrastructure for Safety - SARIS) is scheduled for 2014.

Actions: para. 27, Table 1.1.

Review and improvement of specific aspects of the National Emergency Preparedness and Response Plan (EP&R) (104)

- *How to routinely exercise:*
 - *all involved organizations, up to the ministerial level*
 - *scenarios based on events at multi-unit sites*
- *How to train intervention personnel for potentially severe accident conditions*
- *Rapid intervention team for on-site support*
- *Determination of the Emergency Planning Zone (EPZ) size, which is variable*
- *Transborder arrangements need to be further considered and exercised*
- *Involvement of regional centers to provide site support*
- *Education of the public and the media in aspects related to emergencies (e.g. radiation doses and their effects).*

The national emergency preparedness and response plan (in Ukraine this document is entitled "Plan of Response to Radiation Accidents, NP-306.5.01/3.083-2004") shall be reviewed on a regular basis – every 5 years. The document sets requirements for emergency planning, distribution of responsibilities on responding to radiation accidents between the participants, local and central executive authorities, and to organization of emergency exercises. Today, the document is effective in its 2010 revision; the date of the next review is 2015. The new revision will incorporate all amendments to the legislative framework and structure of response participants.

A detailed description of the preparedness and response system, as well as involvement of organizations at all levels (including the ministerial level), is given in para. 6.1.1 of Part 1 and para. 6.1.6 of Part 2 of the National Report of Ukraine.

Based on the Hydrometeorological Center within the State Emergency Service of Ukraine, there are plans to establish a Radiation Accident Consequences Forecast Centre intended for on-line analysis of assessment and forecast data and providing consultations to the Emergency Response Centre of the National Nuclear Operator *Energoatom* and other organizations involved in emergency response to NPP accidents.

The "Procedure for Taking Urgent Actions on Iodine Prophylaxis among the Population of Ukraine in Case of a Radiation Accident" (NP 306.1.174-2011) was developed and approved (SNRIU Order No. 154 dated 8 November 2011, registered with the Ministry of Justice of Ukraine, reg. No. 1353/20091 dated 25 November 2011).

The document "Requirements for Sizing and Defining Borders of the NPP Observation Area" (NP 306.2.173-2011) was developed and approved (SNRIU Order No. 153/766 dated 7 November 2011, registered with the Ministry of Justice of Ukraine, reg. No. 1343/20081 dated 24 November 2011).

Ukraine participates in the project on establishment of an integrated Regional Emergency Response Centre for NPPs with WWER Reactors based on the Emergency Response Centre of the *Rosenergoatom* Concern, to support decision-making in case of severe accidents (in cooperation with all operating companies affiliated with the WANO Moscow Centre).

Pursuant to Cabinet Resolution No. 58 dated 1 February 2012, activities are underway on "Approval of the Action Plan on Educational Campaign for the Population Residing in NPP Observation Areas".

No provisions for supplementary actions

Openness, transparency, and communication improvements (105):

- *Communication with stakeholders is a continuous activity not just in an emergency*
- *Active stakeholder engagement in the decision-making process builds public confidence*
- *International bilateral cooperation can be beneficial (e.g. joint regulatory inspections)*
- *The proper balance of understandable information provided to informed groups and the general public needs to be addressed*
- *The transparency of the operators' activities needs to be enhanced*

The SNRIU is building an active dialogue with the public according to the Communication Plan of the Inspectorate, in a manner responsive to the public opinion on the level of nuclear and radiation safety.

Current information (in Ukrainian, English and Russian) is posted and updated on the SNRIU web-site (<http://www.snrc.gov.ua>). In 2012, SNRIU launched its page in Facebook social network.

In its report on IRRS mission to Ukraine in 2008, the IAEA defined the Inspectorate's practice of regular (twice a month) telephone hotlines with the SNRIU management, establishment and operation of the Public Council within the SNRIU to ensure transparency in decision-making as Ukraine's good practice.

To ensure the right of civil society for preparing and making decisions on nuclear and radiation safety, before any critical decision is made, it is negotiated with all stakeholders through e-consultations on the web-site and/or open sessions of the SNRIU Board where all stakeholders are invited.

To ensure adequate distribution of comprehensible and accessible information among dedicated groups and general public, the SNRIU makes available its annual reports on the level of nuclear and radiation safety, issues press releases and invites seminars for different target groups – the public, experts, other executive bodies, etc.

Transparency of the operating organization. The National Nuclear Operator *Energoatom* persists in covering the most critical events and decisions related to forming and implementing the state policy in the field of nuclear power use, nuclear power plants' safety, and the prestige of a career in nuclear engineering. The unit responsible for the consistent information campaign of *Energoatom* is the Press Centre that coordinates activities of information services of the KhNPP, RNPP, ZNPP, SU NPP, and Separated Entity *Atomprojectengineering*.

Interactions with the media are effected through press-conferences, publications in printed and electronic media, televised and radio addresses of the *Energoatom* management, updating

Energoatom's web-site, and public outreach events. To ensure continuous bilateral feedback, *Energoatom* monitors the media for related publications on a daily basis (internet, television, radio, printed news sources – not only national but also regional media), which allows *Energoatom* to promptly respond to comments made by the public and the media.

Interactions with the media resulted in increased presence of the *Energoatom* management in the media, which is a significant achievement (systematic cooperation with the leading published news sources "Dzerkalo Tyzhnya" (The Weekly Mirror), "Segodnya" (The Today), "Uryadovyi Kurier" (The Government Messenger), "Holos Ukrayiny" (The Voice of Ukraine), "Komsomolskaya Pravda v Ukraine" (The Komsomol Truth in Ukraine). Topical hot issues are commented on by the *Energoatom* management and experts on national television channels ("Inter", "UT-1", "ICTV", "Era", UBR). Moreover, there is a corporate series "Energoblok" (Power Unit) on the "Pershyi Natsionalnyi" (Prime National) channel.

The Press Centre issues a publication "Energoatom of Ukraine" that gives continued coverage of the safety issues in the nuclear power industry. In addition, the information services of the NPPs issue weekly publications "Outlook" (KhNPP), "Energy" (RNPP), "Energy" (ZNPP), "Power Engineer" (SU NPP) and prepare television and radio programs.

The Press Centre continuously informs the media of any current events in the *Energoatom* through the *Energoatom* public web-site (<http://www.energoatom.kiev.ua/>). Dedicated NPP sites are also created and maintained for all NPPs (<http://www.npp.zp.ua/>, <http://www.rnpp.rv.ua/>, <http://www.sunpp.mk.ua/>, <http://www.xaec.org.ua/>). All information materials are sent to e-mails of the leading media sources.

The possibility for joint regulatory inspections is provided for in a number of bilateral agreements between the SNRIU and regulators of the Contracting Parties, namely the Czech Republic, the People's Republic of China, the Russian Federation, the Republic of Bulgaria.

Actions: recommendations on organization of joint regulatory inspections will continue to be considered in any joint cooperative actions within current international agreements, and in preparing contractual documents with other Contracting Parties.

Post-Fukushima safety reassessments and action plans (106)

- *All CPs should perform safety reassessments and the resolution of their findings should be progressed through a national action plan or other transparent means and should not be limited to NPPs in operation*
- *Established safety networks should be efficiently used by CPs to disseminate and share relevant information*

Ukraine completed stress tests for NPPs in accordance with the methodology approved by the ENSREG, and stress-test results were evaluated by independent experts within a peer review. The stress-test process was open and transparent through all stages, with the public involved in the process and attending open sessions of the SNRIU Board convened to review the stress-test results and the National Report of Ukraine.

This National Action Plan is designed to ensure that the stress-test results and peer review recommendations are taken into account.

In 2012 the SNRIU initiated a periodic safety review for research reactors taking into account the lessons learned from the Fukushima-1 accident.

No provisions for supplementary actions

Human and organizational factors (HOF) (107)

- *There is a need to further develop human resource capacities and competence across all organizations in the field of nuclear safety*
- *Governmental level commitment is needed to ensure a long-term approach for capacity building*
- *Collaborative work is needed in the area of improving and assessing HOF, including safety culture*
- *The role of sub-contractors may be important; can they be harnessed quickly?*

To ensure operation of NPP units, human resources are continuously developed. The operating organization has defined qualification requirements for all personnel categories and primarily for the personnel whose operations impact nuclear and radiation safety. The personnel training process is based on training curricula developed by the educational and training centers of NPPs, and is conducted both in production departments of NPPs and by external organizations involved in the training process. The training process extensively takes advantage of technical training aids including full-scope simulators (FSS) developed for all reactor types; computer training programs; distance education systems; simulators, mock-ups and full-scale equipment of power units.

The personnel preparedness for emergency response, accident management and prevention of recurring issues in NPP operation are ensured through arrangement of the following:

- emergency exercises incorporated in individual training programs for a given position;
- emergency exercises for the operating personnel of a shift;
- educational and training exercises using full-scope simulators for the operating personnel as part of professional development programs;
- full-scope exercises on response to beyond design basis accidents.

All personnel whose operations impact nuclear and radiation safety undergo knowledge test of nuclear and radiation safety regulations and standards with dedicated commissions. Personnel are permitted to work after successful knowledge tests.

During NPP personnel training, particular focus is given to safety culture and acknowledgement of the safety priority. The theoretical course “Safety Culture” is a mandatory integral part of both position training and professional development programs for all personnel. The training focuses not only on personnel knowledge and comprehension of safety culture issues, attention is also given to making consistent compliance with the safety culture principles and internal needs.

Moreover, each training course, when addressing equipment and its operational modes, teaches safety culture aspects by reviewing issues resulting from personnel performance and analyzing the most common personnel errors during NPP operation.

Representatives of NPPs’ training centers are involved in investigations of NPP operational occurrences and development of prevention measures to avoid their recurrence. Operational occurrences, including those at other NPPs, are analyzed by the responsible staff assigned from the training centers of NPPs, the training materials are corrected where necessary and additional training is arranged.

Cabinet Resolution No. 736-r dated 3 August 2011 approved the Action Plan on ensuring openness and availability/accessibility of information on nuclear power use and safety culture improvement in the nuclear power industry.

A detailed description of the preparedness and response system, as well as involvement of organizations at all levels (including the ministerial level), is given in para. 6.1.1 of Part 1 and para. 6.1.6 of Part 2 of the National Report of Ukraine. Available tools and human resources are sufficient for accident management and mitigation, without involvement of contracting/subcontracting organizations.

Section 5. Emergency Preparedness and Response

Expansion of the set of scenarios on which the plan was based – NPP plus Infrastructure / NPP plus chemical plant (108)

In 2011 scenarios were developed for events caused by external hazards that considered the Fukushima-1 accident and included station blackout and loss of ultimate heat sink. Using these scenarios, additional emergency exercises were conducted at all operating NPP sites and at the decommissioned Chornobyl NPP. The scenario of one of the two emergency exercises conducted in 2012 included extraordinary geological and hydrological situations.

Scenarios for each general plant emergency training incorporate recommendations of significant operating experience reports: WANO SOER 2002-1 “Severe Weather”, WANO SOER 2002-2 “Emergency Power Reliability” and WANO SOER 2011-2 “Fukushima Daiichi Nuclear Station Fuel Damage Caused by Earthquake and Tsunami”.

No provisions for supplementary actions

Increasing the scope of off-site exercise programs to reflect simultaneous problems for NPP plus external infrastructure (109)

Common general plant emergency exercises are organized at each NPP every three years, involving the operating company, the state nuclear regulatory body and other central executive bodies. Considering the number of operating NPPs, there is one full-scope emergency training organized annually, and two every third year.

According to the Plan of Response to Radiation Accidents, state-level emergency exercises are arranged at least every five years. The exercises are organized and conducted by the State Emergency Service of Ukraine with involvement of the Ministry of Energy and Coal Industry of Ukraine, Ministry of Health, Ministry of Ecology and Natural Resources, SNRIU and other central executive bodies subject to the emergency training program.

The information on emergency exercises organized at NPP sites in 2011 is given in paras. 7.3, 6.1.6 Ch of the National Report of Ukraine.

In 2012, general plant emergency exercises were organized at SUNPP (6-7 June 2012) and ZNPP (10-11 October 2012), and the training scenario at ZNPP included extraordinary geological and hydrological situation.

The scope of emergency exercises included training for emergency response forces in extreme natural events that cause collapse/loss of infrastructure components, e.g. power supply, water supply or transport communication.

No provisions for supplementary actions

Use of mobile resources in planning and training programs (110)

Mobile radiological laboratories for sampling of environment components and measurement of radiation levels in the area are available at each NPP, which is a requirement of the regulatory document “Health and Safety Rules for Designing and Operation of Nuclear Power Plants”.

The Rivne NPP and Khmelnytsky NPP, as well as the *Energoatom* Emergency and Technical Centre, have mobile laboratories at their disposal and continuously use them in emergency exercises. There are also plans for equipping the Zaporizhzhya NPP and South Ukraine NPP with mobile laboratories.

The possibility for the normal use of mobile laboratories equipped with radiation, meteorological and hydrologic data instrumentation in emergencies is addressed in the Concept of a Unified State Automated Radiation Monitoring System in Ukraine. The Action Plan for establishment of the Unified State Automated Radiation Monitoring System is approved by Cabinet Resolution No. 44-r dated 25 January 2012.

Actions: paras. 28,29, Table 1.1

Increasing emphasis on exercises with neighboring countries (111)

In the framework of the Convention on Early Notification of a Nuclear Accident, Ukraine has signed and put into effect 13 intergovernmental agreements with neighboring countries. The State Nuclear Regulatory Inspectorate of Ukraine regularly tests communication with National Warning Points/Competent Authorities of these countries to check the performance of communication means and relevance of contact numbers. In addition, in the framework of these agreements, the protocols on cooperation in conducting emergency exercises were signed with Hungary, Latvia and Poland. Joint actions provided by these protocols are routinely exercised during activation of the SNRIU Emergency Response and Information Centre during emergency exercises.

No provisions for supplementary actions

Exercising all interface points (national, regional, municipal...) (112)

Respective emergency response structures of the state regulatory and supervisory bodies, as well as central and local executive authorities, participate in the annual emergency response exercises held by the operating organization at one of the NPPs. During exercises, the emergency plans are verified for adequacy and interrelation, the actions on early coordinated response of the administrative bodies, forces and resources of functional and territorial subsystems of the Unified State System of Civil Protection of the Public and Territories at all levels (facility, local, regional and national levels) are worked through.

No provisions for supplementary actions

Performance of longer exercises to reflect the challenges of extreme events (113)

As a rule, full-scale exercises based on general plant emergency training last more than 24 hours, up to two days, with an overnight stand-off. Emergency structures of the regulatory body as a rule are activated for 7-8 hours.

Actions : para. 30, Table 1.1

Enhancing radiation monitoring and communication systems by additional diversification / redundancy (114)

At present, the national hydrometeorological service performs routine measurements of gamma-radiation dose rates using portable equipment at the whole territory of Ukraine. Corporate automated systems carry out radiation monitoring on the territory of the Chernobyl exclusion zone, within the 30 km areas around the Rivne and Khmelnytsky NPPs. Upgrading of radiation monitoring systems within the 30 km areas around the South Ukraine and Zaporizhzhya NPPs is envisaged till 2015.

The existing radiation monitoring system will be improved by establishing the Unified State Automated Radiation Monitoring System in Ukraine – see (110).

In compliance with applicable legislation and with the aim of public notification of emergency threats and regular public informing, state and territorial automated systems of centralized public notification were established in Ukraine, organizational and technical aspects in establishing territorial systems of centralized notification and notification of business entities, centralized use of state and industry communication systems, radio broadcasting and TV networks were provided.

Information support of the Unified State System of Civil Protection of the Public and Territories is provided by the Emergency Control Centre of the State Emergency Service of Ukraine, by efforts and means of the Governmental Information and Analytical System for Emergencies, by information services of the enterprises, institutions, organizations and potentially hazardous facilities, with communication and data transmission facilities being involved.

The special regulation approved by the Cabinet of Ministers of Ukraine determines procedure for collection of information on public and territory protection and its exchange with central and local executive authorities, other responsible authorities.

All Emergency Response Centers (Crisis Centers) of the National Nuclear Operator *Energoatom* are integrated into a joint system via redundant communication channels, including space communication, and unified data transmission system. The dedicated telephone communication channels connect NPPs and SNRIU Emergency Response and Information Centre.

No provisions for supplementary actions

Development of a common source term estimation approach (115)

A common source term estimation approach is developed by implementation in Ukraine of the RODOS decision support system (real-time, on-line, decision support). Activities are performed in the framework of two EC projects, namely: U3.02/08 "Support SNRIU to implement RODOS in the Information and Emergency Centre" (customizing RODOS for Zaporizhzhya NPP and Rivne NPP) and U1.05/09T6 "Development of an Enhanced, Totally Integrated Energoatom/NPP Control System for the Effective Management and Coordinated Response to Emergency Situations" (customizing RODOS for Khmelnytsky NPP and South Ukraine NPP).

Actions: para. 31, Table. 1.1

Providing access to a "big picture" (international picture) of radiological conditions (116)

Ukraine is a party to the Convention on Early Notification of a Nuclear Accident and to the Convention on the Assistance in Case of a Nuclear Accident or Radiological Emergency. According to the Conventions, Ukraine provides information and has access to the data disseminated by the IAEA Incident and Emergency Centre and by the competent authorities of the Parties to the Conventions.

No provisions for supplementary actions

Development of reference levels for transborder processing of goods and services such as container transport (117)

The levels that allow transportation and customs procedures are established in the regulatory document "Regulations for Nuclear and Radiation Safety during Transportation of Radioactive Materials" developed in line with requirements of the IAEA document "Regulations for the Safe Transport of Radioactive Material. 2005 Edition. Safety Series, TS-R-1, IAEA".

No provisions for supplementary actions

Re-examination of approach and associated limits to govern the "remediation" phase (118)

According to legislative requirements, it is the operator's responsibility to bring the territory to the environmentally safe condition. Currently, the regulatory document "Procedure for Exemption of NPP Sites from Regulatory Control upon Completion of Decommissioning Activities" is being developed.

No provisions for supplementary actions

Develop criteria for the return to evacuated area and criteria for return to normal from emergency state (119)

The regulatory document "Radiation Safety Standards of Ukraine" establishes criteria for making decisions on post-evacuation return of population to the places of residence and levels for making decisions on cessation of countermeasures.

No provisions for supplementary actions

Improvement of the approach to establish contamination monitoring protocols and locations during the recovery phase (120)

The issues concerning the procedure for radiation contamination monitoring during the recovery phase will be considered in the Concept of the Unified State Automated Radiation Monitoring System in Ukraine – see (110).

No provisions for supplementary actions

Strengthening of support infrastructure (emergency response centers, sheltering facilities, essential support facilities (like corporate offices) with back-up power, environmental radiological filtering, etc. (121)

Each NPP established and supports on-site (on the NPP site) and off-site (in the observation area) emergency response centers in line with the regulatory document NP 306.202/3.077-2003 “Requirements for On-Site and Off-Site Emergency Response Centers”. All *Energoatom* emergency response centers are united into one system through redundant communication channels, including space communication channels, and through unified data transmission system. The Technical Emergency Response Centre operates in the structure of *Energoatom*, while the Emergency Response and Information Centre operates within the SNRIU.

Actions: para. 32, Table 1.1

Analyzing medical and human aspects of response to support emergency workers (122)

The Ministry of Health of Ukraine reviews a number of documents with regard to establishing a relationship between diseases and ionizing radiation. Activities on establishing and supporting the Unified State System for Accountancy and Control of Individual Exposure Doses are ongoing. The national centre of radiation medicine carries out activities on establishing doses of emergency response personnel.

No provisions for supplementary actions

Implementation of processes to enable access to inter-country support including customs processes for access for diplomats and emergency response personnel (123)

In compliance with requirements for the Unified State System of Prevention of and Response to Man-Induced and Natural Emergencies, the Ministry of Foreign Affairs of Ukraine ensures urgent issuance of required documents and the Administration of the State Border Guard Service ensures simplified border-crossing regime for forces and vehicles /tools of emergency search and rescue teams in case of emergencies.

No provisions for supplementary actions

Systematic assessment of all aspects of organizations that contribute to emergency response using tools like job and task analysis (124)

The SNRIU takes part in general plant emergency training organized by the operator: National Nuclear Operator *Energoatom*. Based on the training results, actions of the emergency facility personnel on protection of the population and personnel, actions on bringing a conditional emergency facility to the safe condition, actions of the operating organization’s personnel and state of the emergency preparedness and response system are assessed. Training results are thoroughly analyzed and used to plan and implement respective corrective actions aimed at improvement of emergency preparedness and response system of the SNRIU, Ukrainian NPPs and *Energoatom* and at improvement of their coordination in emergencies.

The SNRIU comments and proposals resulting from the analysis of actions of NPP and *Energoatom* personnel were considered during review of the “Fundamentals for Organization of the *Energoatom* System of Preparedness for and Response to Accidents and Emergencies at NPPs”, “Emergency Response Plan of *Energoatom* Headquarters” and “Standard Plan of Response to Accidents and Emergencies at Ukrainian NPPs”.

No provisions for supplementary actions.

*Develop radiological reference levels for rescue and emergency response personnel in extreme events (125)**Develop reference levels for the application of immediate countermeasures such as sheltering, iodine distribution and evacuation (126)*

Levels of planned increased exposure to personnel in unforeseen situations, as well as reference levels for implementation of urgent countermeasures (sheltering, iodine prophylaxis, evacuation), are established in the document “Radiation Safety Standards of Ukraine”.

No provisions for supplementary actions

Section 6. International Cooperation*Strengthening the peer reviews process of CNS and of missions (IAEA, WANO and Industry) (127)*

- Effectiveness of IAEA peer review processes should be reviewed in response to concerns raised by the public and non-governmental organizations
- The CNS national reports should describe how peer review and mission findings have been addressed
- Processes and initiatives should be strengthened to ensure implementation of findings of the peer reviews and missions
- CNS review meetings should ensure robust peer reviews and reporting of peer review results and findings

Since its acceding to the CNS, Ukraine has taken an active part in the convention processes and carefully confirmed implementation of its obligations according to the Convention, which is acknowledged by the findings of five review meetings.

The accident in March 2011 at the Fukushima-1 NPP proved the need for improvement of existing international regimes and strengthening their effectiveness. This process also covers the CNS and its review mechanisms.

In view of the above, the IAEA has launched the review process of CNS and related procedural documents with the aim to strengthen its effectiveness and encouraged the state parties to the Convention to take active part in the process.

In 2012, the IAEA established a special working group on the Convention’s effectiveness and transparency. Any state party to the CNS that strives to contribute to the enhancement of the Convention’s effectiveness may join this working group. The first meeting of the group was held in Vienna on 4-6 February 2013.

Actions:

- ensure active participation of Ukrainian experts in activities of the working group on the CNS effectiveness and transparency;
- continue practice of inviting international review missions on regulatory infrastructure and NPP operational safety;
- include the mission findings in the CNS National Reports with the aim to disseminate the gained experience among the other countries.

Strengthening the peer reviews process of CNS and of missions (IAEA, WANO and Industry) (128) – continued

- Plant design safety features and related modifications should be considered in WANO and OSART missions
- Better coordination of WANO and IAEA peer review activities should be established
- International experience gained from the review of Russian designs after Chernobyl could be considered as an example of good international practice

As specified in the National Report of Ukraine (para. 7.2), in the framework of the EC-IAEA-Ukraine Joint Project “Safety Evaluation of Ukrainian Nuclear Power Plants” (Memorandum of Understanding on Cooperation in the Field of Energy between the EU and Ukraine), there were IAEA missions held in the following areas:

- engineering safety review (ESRS);
- operational safety review (OSART);
- radioactive waste review (RWRS);
- integrated regulatory review (IRRS) – see (103).

The detailed results of the Project are presented in the “Final Project Report. EC-IAEA-UKRAINE Joint Project: “Safety Evaluation of Ukrainian Nuclear Power Plants”. Supporting the Implementation of the Roadmap for Nuclear Safety of the Memorandum of Understanding on Cooperation in the Field of Energy between the EU and Ukraine. IAEA-EC Agreement No. 2007/145268”.

Strengthening communication mechanisms through regional and bilateral cooperation (130)

- Initiatives relating to the regional crisis centre for operators of NPPs with WWER type reactors being implemented by the WANO Moscow Centre and also considered by some other vendor countries
- Bilateral agreements between vendor countries and new embarking countries, complemented by IAEA standards and review processes, have been reported to be effective and should be encouraged
- Strong support of political leaders is important to establish the necessary nuclear safety infrastructure.
- Countries with established nuclear programs should assist with the establishment of nuclear and regulatory infrastructure
- Countries should cooperate with neighboring and regional states and exchange information on their civil nuclear power programs

Ukraine supports the initiative of the *Rosenergoatom* Concern under the aegis of the WANO Moscow Centre on establishing a Regional Crisis Centre for NPPs with WWER type reactors on the basis of *Rosenergoatom*'s Crisis Centre. The National Nuclear Operator *Energoatom* representing Ukraine is confirmed as a participant in establishment of the Regional Crisis Centre. The subsequent actions will be implemented according to the plans approved by WANO.

Information and plans on regional cooperation – see (101).

Activities of the SNRIU bilateral cooperation are implemented in the framework of interagency agreements, memoranda, protocols of intent, arrangements, plans of joint actions between regulatory bodies of the countries of various regions.

The State Nuclear Regulatory Inspectorate of Ukraine established sustainable partnership on issues of mutual interest with regulatory bodies of the Czech Republic, Republic of Poland, Republic of Lithuania, Federal Republic of Germany, Republic of Finland, Kingdom of Sweden, French Republic, Kingdom of Spain, Republic of India, People's Republic of China, Republic of Belarus, Republic of Azerbaijan, Federal Republic of Brazil, USA, Republic of Bulgaria, Russian Federation, Republic of Turkey.

In the near future, it is planned to start cooperation on information exchange in the field of nuclear and radiation safety regulation, elaborate regulatory and legislative framework with new partners, and review formats and mechanisms of current cooperation.

Ukraine carefully observes its commitments under agreements on early notification of nuclear accident with 14 European countries.

An individual area of Ukraine's international cooperation is transit of nuclear materials from the Russian Federation to the EU countries (Bulgaria, Czech Republic, Hungary, Slovak Republic) via the territory of Ukraine. Ukraine has completed review of a number of outdated intergovernmental agreements by signing new ones, which consider the full scope of modifications in the regulatory and legislative framework of the parties, and utmost upgrading of measures on physical protection and control of nuclear material during transportation.

The SNRIU is open and ready for a dialogue with new partners that wish to study long-term experience of Ukraine in the field of nuclear and radiation safety regulation.

Actions:

- promote signing of Agreement on Cooperation in the Field of Nuclear and Radiation Safety between the State Nuclear Regulatory Inspectorate of Ukraine and the Ministry of Emergencies of the Republic of Belarus;
- launch negotiations with the Russian Federation on the possibility to sign an agreement on early notification of nuclear accidents and exchange of information in the field of nuclear and radiation safety between the Cabinet of Ministers of Ukraine and the Government of the Russian Federation;
- start negotiations with the Kingdom of Sweden regarding review of effective provisions of the Agreement on Early Notification of a Nuclear Accident to bring it into compliance with current requirements;
- ensure signing the Cooperation Agreement between the State Nuclear Regulatory Inspectorate of Ukraine and the Italian National Institute for Environmental Protection and Research (ISPRA) in the field of nuclear and radiation safety;
- hold consultations with the regulatory bodies of Spain and Canada regarding preparation for conclusion of interagency agreements on promotion of and deepening bilateral cooperation.

Effectiveness of experience feedback mechanisms (131)

- Information exchange and feedback should be enhanced by using the established mechanisms (e.g. IRS, INES) and organizations (e.g. WANO)
- The sharing and utilization of information are limited and not always necessarily well-coordinated or disseminated. This has been identified as an area for improvement
- All nuclear power plants should share operating experience
- The current focus is on reporting events and not necessarily on learning from the events. Effectiveness of operating experience feedback should be assessed and its implementation should be included in peer reviews

Experience Exchange. In compliance with Ukrainian nuclear and radiation safety requirements, all NPPs and the operating organization have established systems for operating experience accumulation, analysis and use. According to the self-assessment of NPPs and operating organization for the last two years, this system meets all the requirements of the national legislation of Ukraine and recommendations of the IAEA and WANO.

The information on all operational occurrences and emergencies at Ukrainian NPPs is communicated to the SNRIU and other organizations, including international ones (IAEA, WANO).

The operating organization makes provisions for collection, processing and analysis of information on equipment failures and human errors at Ukrainian and foreign NPPs (via IAEA and WANO information systems), for categorization and immediate transmission of the received information. Information on equipment failures and human errors is included in the annual reports on current safety status.

Safe operation of NPPs is supported by an information database on incidents, which is part of the operating organization's unified Information system on Operating Events at Ukrainian NPPs. The National Nuclear Operator *Energoatom* has implemented programs that ensure operating experience information exchange:

- *Ukrainian Reliability Database* (for engineering support of the system for equipment flaw detection and determination of reliability of safety-important equipment and systems);
- *Information System on Operating Events* (for collection, processing, analysis and storage of information on equipment failures and human errors);
- *WWER NPP Operating Safety and Technical Condition Evaluation System* (for preparation of

reports on NPP performance indicators and current status of power units' safety). Operating experience is carefully analyzed and disseminated. For this purpose, special subdivisions are established at the operating organization and NPPs. Significant events are reported on a regular basis to the IAEA and WANO under bilateral information exchange. NPPs and the operating organization have access to the databases of the IAEA (IRS) and WANO, their information being continuously analyzed, disseminated and used.

Relevant relations are maintained with NPP design institutions, research organizations and equipment manufacturers in order to bring the operating experience to their knowledge and receive appropriate recommendations.

The operating organization maintains continuous contact with the Russian Federation utility and organizations that were involved in NPP design and continue relevant engineering support (e.g. National Research Centre "Kurchatov Institute", Experimental and Design Organization "Gidropress", Federal State Unitary Enterprise "State Scientific Centre of Russian Federation – Research Institute of Nuclear Reactors").

Strengthening and expanded use of IAEA Safety Standards (132)

- *The Safety Fundamentals remain appropriate as a sound basis for nuclear safety when properly implemented*

- *Implementation should strike the right balance between prevention and mitigation*
- *The IAEA Safety Standards should be taken into account in developing national nuclear safety regulations*
- *These Safety Standards have a role to play in seeking continuous improvements to safety at existing nuclear power plants*

SNRIU Order No. 83 dated 10 July 2002 approved the procedure for developing and issuing codes and standards on nuclear and radiation safety. According to the procedure, the regulations are developed, in particular, considering operating experience in the field of nuclear energy, current scientific and technical achievements, related documents of international organizations, regulatory guidelines and other respective information given by the regulatory bodies of other countries. In elaborating new regulations and reviewing applicable documents, the SNRIU takes into consideration IAEA standards.

No provisions for supplementary actions

Part III. Additional Topics and Activities

7.1 Recommendations of the Peer Review of Stress Tests for Ukrainian NPPs

i) Peer review country report. Stress tests performed on European nuclear power plants. Ukraine.

ii) Commission staff working document. Technical summary on the implementation of comprehensive risk and safety assessments of nuclear power plants in the European Union. Accompanying the document. Communication from the Commission to the Council and the European Parliament on the comprehensive risk and safety assessments ("stress tests") of nuclear power plants in the European Union and related activities.

it is recommended that the national regulator should monitor in a systematic way the implementation of the upgrading measures identified upon stress tests and included into the Comprehensive (Integrated) Safety Improvement Program (C(I)SIP) i) para. 2.1.3, ii) para. 6.2

The Comprehensive (Integrated) Safety Improvement Program for Nuclear Power Plants was approved by Cabinet Resolution No. 1270 dated 7 December 2011. The operating organization annually develops schedules for implementation of C(I)SIP measures for all NPPs and agrees them with the SNRIU, Ministry of Fuel and Coal Industry and State Technology-related Safety Inspectorate. Compliance with the schedule is a licensing condition.

It should be additionally noted that the SNRIU Board meeting was held on 20 November 2012 (SNRIU Board Resolution No. 14 "On the progress of implementation of measures based on stress-tests results for operating NPPs" dated 20 November 2012) to monitor implementation of safety upgrades following stress tests at Ukrainian NPPs.

The status of C(I)SIP measures at SUNPP-1 in the context of preparations for long-term operation was addressed at the SNRIU Board meetings on 27 April and 20 December 2012.

On 14 February 2013, the SNRIU Board meeting "On status of safety improvement measures at nuclear power plants in 2012" was held to consider the implementation of C(I)SIP measures by the operating organization in 2012.

No provisions for supplementary actions

It is recommended that the national regulator should give priority to achieving or enhancing the schedule of C(I)SIP measures. This should include due consideration of parallel needs arising from envisaged long-term operation i) para. 1.3

The operating organization set priorities to C(I)SIP measures and SNRIU Board Resolution No. 13 dated 24-25 November 2011 identified a list of measures to be performed by the operating organization to prepare NPP units for long-term operation (para. 7.3 of the National Report of Ukraine).

The list of safety improvement measures to be implemented at SUNPP-1 prior to SNRIU decision on the possibility of long-term operation of this power unit is provided in SNRIU Board Resolution No. 18 dated 20 December 2012.

No provisions for supplementary actions

it is recommended that the national regulator should monitor additional analyses of the threat to the essential service water system resulting from tornado impact and evaluation of emergency arrangements with respect to personnel access to sites in severe weather conditions i) para. 2.3.3, ii) para. 6.2

Following stress tests, the following measures were included into the C(I)SIP: "Functionality of group A equipment fed from the service water system in case of water discharge in spray ponds" (ZNPP, RNPP, SUNPP-3, KhNPP – V-213,320) and "Functionality of group A equipment

fed from the service water system in case of failure of ventilation cooling towers and/or service water supply pumps” (SUNPP-1,2 – V-302, 338) – see paras. 9 and 10, Table 1.1.

In implementation of emergency measures (paras. 5-10, 16, Table 1.1), attention will be given to possible hindered access to NPP sites and long-term performance of basic safety functions by on-site equipment in extreme conditions.

No provisions for supplementary actions

It is recommended that the national regulator should monitor measures related to makeup to the primary circuit, steam generators and spent fuel pools in case of station blackout and loss of the ultimate heat sink and further analyze in detail mobile power and water supply sources

i) para. 3.3, ii) para. 6.2

Following stress tests, appropriate measures were included into the C(I)SIP for all NPP units (paras. 5 and 6, Table 1.1.). To take into account peer review recommendations and to comply with SNRIU Board Resolution No. 14 dated 20 November 2012, the measure “Detailed analysis of primary system makeup in case of loss of power and/or ultimate heat sink” was included in the C(I)SIP (para. 13, Table 1.1).

No provisions for supplementary actions

It is recommended that the national regulator should consider a number of topics on severe accident management (key safety functions needed for SAM; hydrogen management; reliable depressurization of the reactor coolant system in severe accident conditions; qualification of equipment needed in severe accident conditions; scenarios with simultaneous risk from the reactor and spent fuel pool in a severe accident; consideration of the spent fuel pool; habitability of MCR and ECR in severe accident conditions; seismic resistance of buildings housing emergency centers; immediate actions for sites with multiple units)

i) para. 4.3, ii) para. 6.2

These topics will be taken into account by the operating organization in developing and implementing severe accident management guidelines (para. 16, Table 1.1) and by the SNRIU in state review of the guidelines.

No provisions for supplementary actions

It is recommended that the national regulator should consider protection of the population with regard to SAMG provisions

i) para. 4.3

The main criterion in implementing the severe accident management strategies and relevant technical measures is to decrease radioactive releases and protect the population in severe accidents. For the containment venting measure (para. 20, Table 1.1), the gas-steam mixture is to be filtered and radiological consequences are to be considered.

No provisions for supplementary actions

It is recommended that the national regulator should consider seismic re-evaluation of all equipment that performs the relevant safety functions including equipment to cope with station blackout

i) para. 2.1.1.7

Additional seismic investigations of NPP sites and improvement of seismic resistance of NPP equipment, piping, structures and buildings are underway in compliance with C(I)SIP measures – paras. 1,2,4, Table 1.1.

Additional seismic investigations of the South Ukraine NPP were completed (para. 2.1.1 of the National Report of Ukraine); an on-site seismic monitoring system was implemented in 2012.

No provisions for supplementary actions

7.2 Safety Improvement Measures at Chornobyl NPP

In accordance with the National Report of Ukraine (para. 7.3 Ch), following stress tests at Chornobyl NPP units 1–3 and ISF-1 and their state review, the Chornobyl NPP developed the “Safety Improvement Plan for ChNPP Nuclear Installations” and agreed it with the SNRIU on 12 December 2011. The status and schedule of all measures under the Plan are indicated in Part IV (Table 1.2).

7.3 Improvement of the Regulatory and Legal Framework on Nuclear and Radiation Safety

The SNRIU improves the regulatory and legal framework on nuclear and radiation safety on a permanent basis through revision of current and development of new requirements. The SNRIU takes into account IAEA standards in this process.

The post-Fukushima improvement of the regulatory and legal framework is underway within the “Action Plan for special targeted safety reassessment and further safety improvement of Ukrainian NPPs in the light of the events at Fukushima-1”, approved by the Board Resolution dated 19 May 2011.

At the end of 2009, Ukraine joined WENRA as an observer. The revision of current nuclear and radiation safety regulations of Ukraine with the objective to bring them into compliance with the WENRA reference levels is the first priority for the SNRIU. The SNRIU intends to perform self-assessment and develop an action plan for harmonization of national regulations with the WENRA reference levels - para. 26, Table 1.1.

The SNRIU provided translation of the WENRA document “Safety of New NPP Designs”. To fulfill SNRIU Board Resolution No. 15 dated 20 November 2012 “On safety criteria and requirements for construction of new NPP units in the light of the Fukushima accident”, expert discussions (25 December 2012) and public discussions (10 January 2013) were conducted to address basic provisions of the WENRA document to be considered in the improvement of safety requirements for new NPP units in Ukraine.

Part IV. Plan for Implementation of Safety Improvements

Table 1.1 Status of Measures Identified upon Stress Tests at Operating NPPs

No	Measure / activity	Recommendations at European level	Recommendations at national level	Schedule/Status		
				¹ WWER-440/213	² WWER-1000/320	³ WWER-1000/302, 338
Natural Hazards						
1.	Equipment qualification (harsh environments and seismic* impacts)	(5), (6), (11), (13)	[1], [2]	*2015/2015/ongoing	2013/2015/ongoing	2013/2014/ongoing
2.	Seismic resistance of structures, systems and components important to safety	(5)	[1], [2]	2015/2015/ongoing	2014/2017/ongoing	2013/2014/ongoing
3.	Consideration of a full range of initiating events for all reactor and SFP states in PSA	(5)	[1], [2]	2017/2017/ongoing	2013/2016/ongoing	2013/2014/ongoing
4.	Implementation of a seismic monitoring system at NPP sites	(10)	[1], [2]	SUNPP – 2012/completed ZNPP – 2015/ongoing RNPP – 2016/ongoing KhNPP – 2016/ongoing		
Loss of Safety Systems (Loss of Power and/or Ultimate Heat Sink)						
5.	SFP makeup and cooling in long-term SBO conditions	(14), (17), (23), (24), (26), (27), (28)	[1], [2]	2014/2014/ongoing	2014/2017/ongoing	2013/2014/ongoing
6.	SG makeup and cooling in long-term SBO conditions	(14), (17), (24), (26), (27), (28)	[1], [2]	2014/2014/ongoing	2014/2017/ongoing	2013/2014/ongoing
7.	Improved reliability of emergency power supply	(15), (16), (17), (18), (22), (24), (26), (27), (28)	[1], [2]	–	–	2013/2014/ongoing
8.	Emergency power supply in long-term loss of power	(15), (16), (17), (18), (22), (24), (26), (27), (28)	[1], [2]	2014/2014/ongoing	2014/2017/ongoing	–
9.	Functionality of group A equipment fed from the service water system in case of water discharge in spray ponds	(17), (24), (26), (27), (28)	[1], [2]	2014/2014/ongoing	2014/2017/ongoing	–

¹ RNPP unit 1/unit 2

² Pilot unit (ZNPP-1) / final period for implementation of the measures at all power units of this design.

According to nuclear safety regulations, a measure is first implemented at the pilot power units with reactors of each design and then at other units taking into account the pilot experience

³ SUNPP unit 1/unit 2

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No	Measure / activity	Recommendations at European level	Recommendations at national level	Schedule/Status		
				¹ WWER-440/213	² WWER-1000/320	³ WWER-1000/302, 338
10.	Functionality of group A equipment fed from the service water system in case of failure of ventilation cooling towers and/or service water supply pumps	(17), (24), (26), (27), (28)	[1], [2]	–	–	2013/2014 ongoing
11.	Provision of instrumentation during and after accidents (accident and post-accident monitoring system)	(18)	[1], [2]	2014/2014/ongoing	2014/2017/ongoing	2013/2014/ongoing
12.	Development, technical justification, validation and implementation of symptom-oriented emergency operating procedures for management of design-basis and beyond design-basis accidents (low power and shutdown states)	(19), (23)	[1], [2]	2013/2014/ongoing	2013/2014/ongoing	2013/2014/ongoing
13.	Detailed analysis of primary system makeup in case of loss of power and/or ultimate heat sink	(20)	[1], [5]	2015/ongoing	2015/ongoing	2015/ongoing
14.	Replacement of self-contained air conditioners by those qualified for harsh environments and seismic impacts	(22)	[1], [2]	2013/2013/ongoing	2014/2017/ongoing	2013/2014/ongoing
15.	Habitability of MCR and ECR in design-basis and beyond design-basis accidents (installation of iodine filters)	(22)	[1], [2]	completed	–	–
Severe Accident Management						
16.	Severe accident analysis. SAMG development	(39), (41)	[1], [2]	2014/2015/ongoing	2014/2015/ongoing	2013/2014/ongoing
17.	Prevention of early containment bypassing in case of spread of molten corium to the containment	(31), (32)	[1], [2], [5]	–	2014/2017/ongoing	2013/2014/ongoing
18.	Implementation of a containment hydrogen control system for beyond design-basis accidents	(31), (32), (41), (11)	[1], [2]	completed	2014/2017/ongoing	2013/2014/ongoing
19.	Development and implementation of hydrogen mitigation measures for beyond design-basis accidents	(31), (32), (41)	[1], [2]	2015/2015/ongoing	2014/2017/ongoing	2013/2014/ongoing
20.	Implementation of a containment venting system	(31), (32), (41)	[1], [2]	2014/2014/ongoing	2014/2017/ongoing	2013/2014/ongoing
21.	Analysis of the strategy for possible corium confinement within the reactor pressure vessel	(31), (32)	[1], [5]	2015/planned	2015/planned	2015/planned
22.	Analysis of the need and possibility to qualify power unit components that may be involved in severe accident management for harsh environments	(31), (32), (33)	[1], [5]	2015/planned	2015/planned	2015/planned
23.	Detailed analysis and development of conceptual decisions on management with large volumes of contaminated water	(42)		2016/planned	2016/planned	2016/planned

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No	Measure / activity	Recommendations at European level	Recommendations at national level	Schedule/Status		
				¹ WWER-440/213	² WWER-1000/320	³ WWER-1000/302, 338
24.	Seismic evaluation of buildings and systems of the on-site emergency centre and their robustness in severe accident conditions	(43), (44)		ZNPP – 2015/ongoing RNPP - 2015 /ongoing SUNPP - 2015/ongoing KhNPP - 2015/ongoing		
25.	Analysis of severe accident phenomena based on available experimental data and improvement of computer models	(44)		2017/ planned	2017/ planned	2017/ planned
Additional Topics and Activities						
26.	Harmonization of Ukrainian nuclear and radiation safety regulations with WENRA reference levels: a) self-assessment; b) development of a harmonization action plan	(31)		2014 / planned 2014 / planned		
27.	Self-assessment of the nuclear safety regulation system using the new IAEA instrument – SARIS	(103)		2014 / planned		
28.	Provision of mobile laboratories to ZNPP and SUNPP	(110)		2015		
29.	Development of the concept and plan for the unified state automated radiation monitoring system of Ukraine	(110), (114), (120)		2015		
30.	Long-term (more than 24 hours) emergency training for all response parties, including central executive authorities, to test the knowledge transfer procedure in conditions of shift work of emergency staff	(113)		2016		
31.	Implementation of the RODOS system	(115)		2015		
32.	Modernization of the SNRIU Emergency Response and Information Centre	(121)		2015		

Table 1.2 Status of Measures Identified upon Stress Tests at Chernobyl NPP

No	Measure / activity	Recommendations at European level	Recommendations at national level	Status	Schedule
1.	Installation of an additional level control device in 1 (2) fuel assembly cooling pools-1, 2 for emergencies related to level water decrease below marks 19, 22	(18)	[3], [4]	completed	2012
2.	Calculation analysis of buildings of nuclear safety category 1 to determine safety margins and potential failures under loads induced by a tornado of class F 3.0	(13)	[3], [4]	ongoing	2015
3.	Calculation analysis of buildings of nuclear safety category 1 to determine safety margins and potential failures under seismic loads	(13)	[3], [4]	ongoing	2015
4.	Seismic resistance analysis of ISF-1 SFP lining	(23), (30)	[3], [4]	ongoing	2015
5.	Analysis of stability and potential failures of ventilation stack-1 under safe shutdown earthquake and tornado	(23), (30)	[3], [4]	ongoing	2014
6.	Nuclear safety justification for the spent fuel pools of units 1, 2 with 250x110 mm arrangement of SFAs (as reserve for one ISF-1 compartment)	(23), (30)	[3], [4]	completed	2012
7.	Justifying calculation of the maximum fuel cladding temperature taking into account potential radiological consequences from wet SFA storage	(23), (30)	[3], [4]	ongoing	2013
8.	Development of an action plan to improve the emergency preparedness system in case of beyond design-basis accidents caused by natural hazards, including emergency response measures in case of damage of the building and leakage of the spent fuel pool	(26), (28), (34), (38), (39)	[3], [4]	completed	2012
9.	Amendment of the ChNPP accident and emergency response plan (32P-S) to improve emergency preparedness	(26), (28), (34), (37), (39)	[3], [4]	completed	2012
10.	Development of measures on prompt access of emergency teams from Slavutych by alternative routes in case of damage of Slavutych-ChNPP railroad tracks caused by safe shutdown earthquake	(34)	[3], [4]	completed	2012
11.	Modernization of the ISF-1 radiation monitoring system to ensure neutron flux density monitoring	(18), (30)	[3], [4]	completed	2012
12.	Additional radiation monitoring of exposure dose rate of the container car in ISF-1 during spent fuel transportation	(18)	[3], [4]	completed	2012
13.	Replacement of the UDZhG-04R detector with an RWM-02 detector for the instrumentation channel for monitoring the activity concentration of service water after heat exchangers in ISF-1 spent fuel pools	(18)	[3], [4]	ongoing	2013
14.	Power supply to ISF-1 essential equipment fed from mobile DG	(15), (16), (26)	[3], [4]	completed	-
15.	Purchase of a new container car for SFA transportation	(30)	[3], [4]	ongoing	2015

No	Measure / activity	Recommendations at European level	Recommendations at national level	Status	Schedule
16.	Revision of the ISF-1 safety improvement plan	(23), (30)	[3], [4]	completed	2012
17.	Introduction of the topic “multiple failures of regular systems and equipment in severe weather conditions” into the 2012 training program for ChNPP staff of certain positions for detailed theoretical elaboration of the training scenario	(26), (28), (34), (108)	[3], [4]	completed	2012
18.	Introduction of the topic “multiple failures of regular systems and equipment in severe weather conditions” into the 2012 training program (Section 14) for practical exercise by staff of all shifts	(26), (28), (34), (108)	[3], [4]	completed	2012
19.	Psychological training of staff intended to increase resilience to psychological stress, develop self-control, composure and promote mutual aid and cooperation	(38), (122)	[3], [4]	completed	2012
20.	Implementation of a system for psychological selection and training of individuals involved in severe accident management, similar to the system for selection of operating personnel	(38)	[3], [4]	completed	2012

References

1. Comprehensive (Integrated) Safety Improvement Program (C(I)SIP).
2. SNRIU Board Resolution No. 13 dated 24-25 November 2011 “On results of the targeted safety reassessment of operating NPPs and ZNPP dry spent fuel storage facility in the light of the events at Fukushima-1”.
3. SNRIU Board Resolution No. 12 dated 3 November 2011 “On result of the targeted safety reassessment of units 1-3 Chornobyl NPP and Interim Spent Nuclear Fuel Storage Facility in the light of the events at Fukushima-1”.
4. Safety Improvement Plan for ChNPP Nuclear Installations.
5. SNRIU Board Resolution No. 14 dated 20 November 2012 “On the progress of implementation of measures based on stress-tests results for operating NPPs”.