NATIONAL REPORT OF THE RUSSIAN FEDERATION FOR THE SECOND EXTRAORDINARY MEETING OF THE CONTRACTING PARTIES TO THE CONVENTION ON NUCLEAR SAFETY

Moscow 2012

This report of the Russian Federation has been compiled subject to the decisions made in September 2011 at a session of the General Committee of the Fifth Review Meeting of the Convention on Nuclear Safety in the framework of the 55th General Conference of the International Atomic Energy Agency (IAEA). The attending Contracting Parties have agreed to convene the Extraordinary Meeting for exchange of information regarding the steps taken or planned to ensure the safety of nuclear installations based on the analysis of the events at the Fukushima-Daiichi NPP in Japan.

Table of Contents

List of abbreviations

AHE	Air heat exchanger
ALS	Accident localization system
ASN	Autorité de Súrete Nucléaire
BDBA	Beyond design basis accident
BDBA MG	Management guide for beyond design basis accidents
BIHT	Back-up in-house transformer
BRICS	Brazil, Russia, India, China, South Africa
BRU-A	Atmospheric exhaust station
BRU-B	Drum separator bypass valve
BRU-D	Deaerator bypass valve
BRU-K	Turbine bypass valve
CA	Controlled area
CC	Crisis center
CIS	Commonwealth of Independent States (former USSR republics)
CPS	Control and protection system
DBE	Design basis earthquake
DG	Diesel-generator
DGH	Distributing group header
DPS	Diesel-driven pumping station
DS	Drum separator
EC REA	Emergency Commission of Rosenergoatom Concern OJSC
ECCS	Emergency core cooling system
ECS AHE	Emergency cooldown system through air heat exchanger

EDF	Electricitè de France
EFSC	Emergency and Fire Safety Commission
EMERCOM	Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters
ENSREG	European Nuclear Safety Regulator Group
ECCS	Emergency core cooling system
ETC	Emergency technical center
ETL	Electricity transmission line
EWC	Emergency work commander
FEC	Facility Emergency Commission
FMBA	Federal Medical and Biological Agency
G8	Group 8
Hydro	Hydro power plant
I&C	Instrumentation and Controls
IAC	Information and analytical center
IAEA	International Atomic Energy Agency
IBRAE RAS	Nuclear Safety Institute of the Russian Academy of Sciences
INPRO	International Project on Innovative Reactors and Fuel Cycles
INSAG	International Safety Group
ICIS	In-core instrumentation system
IEPES	Industry-wide emergency prevention and elimination system
IHN	In-house needs
IHT	In-house transformer

ISG	Indoor switchgear
LC	Leak-tight compartment
MC	Moscow Center
MCP	Main circulation pump
Media	Mass media
MFA	Ministry of Foreign Affairs
NF	Nuclear facility
NP	Nuclear plant
NPP	Nuclear power plant
NPPA	Nuclear power plants assistance
NRC	Nuclear Regulatory Committee
OECD/NEA	Nuclear Energy Agency of the Organization for Economic Cooperation and Development
OO	Operating organization/Operator
OSART	Operating Safety Analysis Review Team
OSG	Outdoor switchgear
OSPS	On-shore pumping station
P SV	Pressurizer safety valve
PCS	Purge and cooldown system
PDEZ	Purging of dead-end zones
PERCP	Protected emergency response control post
PERCP EA	Protected emergency response control post in the NPP evacuation area
PERCP NPP	Protected emergency response control post at nuclear power plant
PERCP SC	Protected emergency response control post in the NPP’s satellite city

PH RCP	Pressure header of reactor coolant pump
PHEU	Pumping and heat exchanging unit
PHRS	Passive heat removal system
PORV P	Pilot operated relief valve of the pressurizer
PSA	Probabilistic safety analysis
Radwaste	Radioactive waste
RCC	Regional crisis center
RCP	Reactor circulation pump
RFCC	Repeated forced circulation circuit
RI	Reactor installation
RSPEE	Russia-wide System for Prevention and Elimination of Emergencies
SAMG	Severe accidents management guide
SC	State-owned corporation
SCC	Situation and crisis center
SDPS	Standby diesel power station
SFA	Spent fuel assembly
SFP	Spent fuel pool
SG	Steam generator
SNF	Spent nuclear fuel
SNF SF	Spent nuclear fuel storage facility
SO-CDD UES	System Operator – Central Dispatcher Department of the United Electricity System
SSE	Safe shutdown earthquake
SWL	Steam-water lines
TCC	Technical crisis center

TSC	Technical support center
TSO	Technical Support Organization
WANO	World Organization of Nuclear Operators
WSL	Water-steam lines

Introduction

The Russian Federation signed the Convention on Nuclear Safety on 20 September 1994 and adopted the Convention on 12 July 1996. The Convention on Nuclear Safety took effect for Russia on 24 October 1996.

The adherence to the obligations arising out of the Convention on Nuclear Safety was brought to the notice of international comminuty in the Russian Federation’s Fifth National Report at the Contracting Parties Meeting at the IAEA in 2011.

As of 1 March 2012, the Russian Federation has 33 operating units at 10 nuclear plants, including 17 units with pressurized water reactors (VVER), 15 units with channel-type boiling-water reactors and 1 unit with a fast-neutron sodium-cooled reactor. All units have at-reactor SNF storage facilities and there are 4 NPP sites with separate SNF storage facilities. Over the time after the Fifth National Report was presented, Kalinin-4 with the VVER-1000 ractor facility reached its first criticality and was connected to the grid.

There are four units under decommissioning at two sites: Beloyarsk-1,2 have been shut down and have all fuel withdrawn and placed in the at-reactor storage facilities, and Novovoronezh-1,2 have been also shut down and have SNF withdrawn in full.

The construction of Rostov-3,4 with the VVER-1000 reactor installations is continued. In 2014 Beloyarsk-4 built under the BN-800 project is expected to be commissioned. Units with pressurized-water reactors of 1200 MWe are being built under the AES-2006 project at Novovoronezh II and Leningrad II sites. Other units expected to be commissioned under this project until 2020 are Novovoronezh II/1,2, Leningrad II/1-4 and Baltic-1,2.

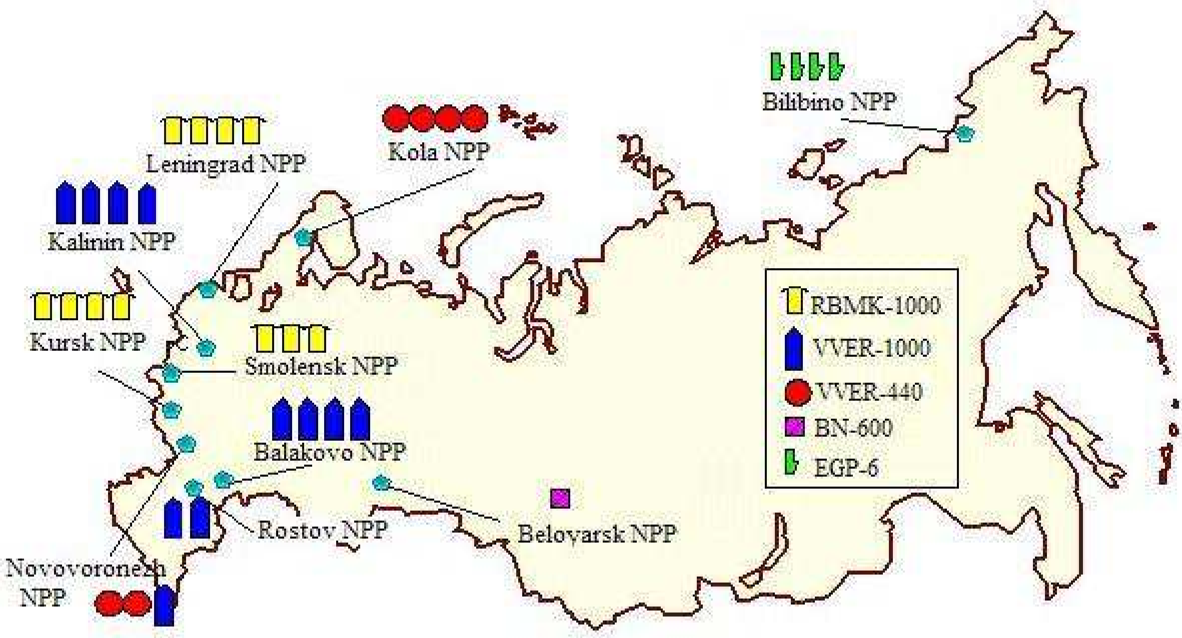

Fig. B.1 shows the geographical locations of the NPP units in operation in the Russian Federation.

Basic data of the Russian NPP units are given in Appendix 1.

The Russian Federation has a legal framework for atomic energy uses, which, among other things, governs issues involved in ensuring safety of nuclear installations. There is a national regulatory body in the Russian Federation (the Federal Environmental, Industrial and Nuclear Supervision Service or Rostechnadzor) reporting directly to the Government of the Russian Federation. Rostechnadzor is responsible for regulatory control, state supervision and inspection, licensing of activities at nuclear facilities, in particular NPP operations.

Open Joint-Stock Company “Russian Concern for Generation of Electric and Thermal Power at Nuclear Power Plants” (Rosenergoatom) is the only operator of the NPPs in operation or under construction in the Russian Federation.

As required by the Convention on Nuclear Safety and the Federal Law “On the Use of Atomic Energy” dated 21 November 1995 (No. 170-FZ), Rosenergoatom is fully responsible for the safety of the Russian nuclear plants in operation.

On a regular basis, Rosenergoatom carries out activities to retrofit and upgrade the safety of NPPs, this making it possible to ensure that they comply with the up-to-date safety requirements and reasonably extend the NPP life.

The funding provided by Rosenergoatom for the NPP retrofit projects in 2000–2011 is shown in Fig. B.2.

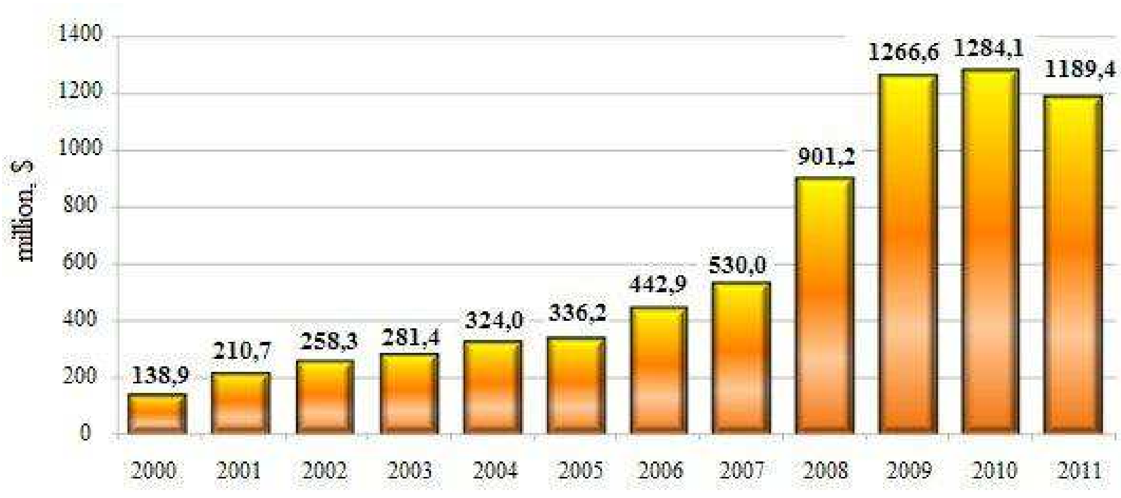

Fig. B.2. Funding of the retrofit activities for the NPPs in operation in Russia

In the Russian Federation, activities are undertaken at a national level to ensure the emergency preparedness of nuclear plants and steps are taken to ensure safety of the personnel, the public and the environment.

On 12 March 2011, after the accident at the Fukushima-Daiichi NPP in Japan was first reported, the emergency operations center, a part of the RSPLE, launched monitoring and prediction with respect to the development of the accident consequences in the border areas.

By 28 March 2011, target inspections were undertaken at all Russian NPPs in operation regarding the adherence to the design safety requirements when reviewing the potential progression scenarios of beyond design basis accidents, given the specific nature of the installation deployment. By 6 April 2011, emergency response drills were conducted at all Russian NPPs for scenarios involving loss of power and loss of heat removal to the ultimate heat sink.

In March and April 2011 inspections of the NPPs were conducted by Rosenergoatom and Rostechnadzor with respect to:

– the degree of protection against extreme natural and man-induced impacts, including impacts of the intensity beyond the NPP design bases and combinations of external impacts;

– preparedness for the management of beyond design basis accidents involving the NPP blackout;

– preparedness for the management of beyond design basis accident involving loss of the ultimate heat sink;

– preparedness for management of severe accidents at NPPs (accidents involving fuel damage beyond the design limits).

On 26 April 2011, by way of a commission from the President of the Russian Federation, proposals on improvements in the international legal regime of ensuring nuclear safety were developed and sent to the leaders of the CIS, G8 and BRICS countries, and to the IAEA Director General.

On 20 June 2011, at the IAEA Ministerial Conference on Nuclear Safety called in the wake of the Fukushima Daiichi accident, the Russian delegation officially unveiled the package of its proposals on making amendments to the Convention on Nuclear Safety. The said amendments envisage a greater government responsibility for timely and sufficient emergency response to minimize the consequences of the accident, and include the requirement for the necessary infrastructure to be established in the countries planning to build nuclear facilities under the IAEA recommendations and with assistance from the nuclear installation vendors. The proposed Russian amendments to the Convention on Nuclear Safety are set forth in Appendix 6 to this National Report. The Russian proposals for the amendments to the Convention on Nuclear Safety were considered in the final Conference Declaration and in the IAEA Nuclear Safety Action Plan adopted at the 55th Session of the IAEA General Conference in September 2011.

In June 2011, the regulatory body, based on the ENSREG approach, developed requirements regarding the scope and content of the additional protectiveness analysis for the existing Russian NPPs.

During the period of 15 June to 15 August 2011, Rosenergoatom submitted to Rostechnadzor reports including the protectiveness analysis data for the existing Russian NPPs regarding the extreme external impacts and combinations thereof, as well as the preparedness of the nuclear plants to the management of beyond design basis accidents, including severe accidents.

In September and November 2011, Rostechnadzor reviewed the submitted reports, with the review results discussed with Rosenergoatom at an enlarged meeting at Rostechnadzor in December 2011.

In early 2012 Rostechnadzor and ROSATOM developed the “Program of Activities for the Participation of the Russian Agencies and Organizations Concerned in the Implementation of the IAEA Nuclear Safety Action Plan”. The activities this envisaged had the purpose of improving the safety of the Russian NPPs and the efficiency of the emergency response system, and raising the efficiency of the Russian safety regulation framework. The program provided for the Russian Federation’s involvement in the international activities concerning the improvement in the efficiency of the international regulatory legal framework and the assistance to the states planning to launch their national nuclear power programs.

1. Topic 1. External Events

1.1. Brief discussion of topic

In the Russian Federation, the issues regarding the NPP protectiveness against external impacts are analyzed at all lifecycle stages of nuclear plants (design, construction, operation, decommissioning) and regulated by federal standards and rules.

The current federal standards and rules require that the maximum parameter values of hydrometeorological, geological and engineering-geological processes and phenomena are defined for the design basis in a time interval of 10000 years. In addition, the design bases make allowances for man-induced factors, which frequency of occurrence is equal to or exceeds 10^{-6} 1/year. Where the effects of natural and man-induced factors have this frequency of occurrence, the NPP protection safety is ensured, which makes it possible to avoid taking measures to exclude damage to the NPP safety important buildings and structures caused by external impacts.

Where natural and man-induced impacts have a smaller frequency of occurrence, provided the frequency of the maximum permissible emergency release is over 10^{-7} 1/year, the accident management for the accident aftermath mitigation should be supported technologically.

Federal standards and rules also require that particular combinations of external impacts to be taken into account in the NPP design bases.

The following natural and technological impacts, which are hazardous to NPPs, were taken into account in the additional analysis regarding the protectiveness of Russian NPPs against extreme external impacts:

– natural impacts:

- seismic;
- floods;
- strong wind (dust storms, tornadoes);
- extreme air temperature;
- snow loads;
- icing;
- other impacts typical of the NPP deployment area and site, as listed in the standards;

– man-induced impacts:

- aircraft crash;
- externally caused fire;
- explosions at facilities in the NPP deployment area;
- atmospheric emissions of toxic vapors, gases and aerosols;
- oil spills on the near-shore surfaces of water bodies;
- other impacts typical of the NPP deployment area and site, as listed in the standards.

Combinations of external impacts were also analyzed, which, as expert assessments show, may occur in the NPP deployment areas.

1.2. Actions taken by the Operator

1.2.a. Overview of actions taken or planned by the Operator

In March and April 2011, Rosenergoatom inspected all existing nuclear plants to audit these for a degree of protection against external natural and man-induced impacts. In June and August 2011, an additional protectiveness analysis was performed by Rosenergoatom for all Russian NPPs with respect to external impacts, subject to the requirements developed by the Regulator based on the ENSREG approach, including the analysis of:

- the protectiveness against seismic impacts taken into account in the NPP design bases (design basis and safe shutdown earthquakes);
- the protectiveness against floods of different origin (abnormal levels in water bodies, the near-shore sea and lake area regimes (tsunamis, storms and so on), incidents at hydraulic works, extreme rainfall) taken into account in the NPP design bases;
- the protectiveness against the external impacts typical of the nuclear plant deployment locality and site, of the intensity taken into account in the NPP design bases;
- the protectiveness of nuclear plants against earthquakes of the intensity in excess of those taken into account in the design bases (the nuclear plant capability to manage anticipated operational events, including accidents caused by beyond design basis earthquakes);
- the physical potentiality of floods in excess of those taken into account in the NPP design bases, and the protectiveness of

nuclear plants against such floods if such floods are not excluded physically;

- the protectiveness of nuclear plants against external impacts in excess of those taken into account in the design bases (the nuclear plant capability to manage anticipated operational events, including accidents caused by beyond-design-basis external impacts);
- the protectiveness of NPPs against particular combinations of external impacts selected by experts (e.g. extreme snow loads and extreme winds).

As part of the analysis, the following issues were considered:

potential of dependent events (e.g., a fire caused by an earthquake);

effects of external impacts on:

- the NPP safety important systems and components (equipment, buildings and structures);
- the NPP systems and components used for the beyond design basis accident management, including communication and notification systems;
- the NPP systems and components, which do not affect safety, but which, if damaged (failed), may cause damage to safety important systems and components;
- systems and components capable of causing an NPP fire, toxic emissions or flooding;

– on-site escape routes, roads and engineering utilities, which are used for the nuclear plant to receive assistance from the outside and for evacuation of humans, the routes used by the personnel for taking actions to ensure the NPP safety, and normally occupied rooms (primarily the main and emergency control rooms, and the protected emergency response management rooms);

– external power lines for the NPP auxiliary power supply.

major safety functions (subcriticality control, heat removal from cores and nuclear fuel inventory rooms) to be ensured when external impacts are in effect;

the existing safety margins.

Both the NPP design materials and the data from the additional surveys conducted by the design organizations and Rosenergoatom prior to and after the accident at the Fukushima-Daiichi NPP, were used for the analysis.

Seismically, as required by federal standards and rules, each of the Russian NPP sites is characterized by magnitudes of the design basis and the safe shutdown earthquake. The maximum-intensity on-site earthquake of the occurrence frequency once in 1000 years is referred to as the design basis earthquake. The maximum-intensity onsite earthquake of the occurrence frequency once in 10000 years is referred to as the safe shutdown earthquake.

Table 1.1 gives magnitudes of the design basis and the safe shutdown earthquakes and their respective ground accelerations for each of ten Russian NPP sites.

Tables 1.1.

Magnitudes of the design-basis and the safe shutdown earthquakes and their respective ground accelerations for the Russian NPP sites

NPP site	MSK-64 magnitude		Ground accelerations, m/s^2	
	DBE	SSE	DBE	UDBE
Balakovo	6	7	0.050 g	0.100 g
Beloyarsk	5	6	0.025 g	0.050 g
Bilibino	4	5	0.020 g	0.035 g
Kalinin	4	5	0.020 g	0.040 g
Kola	4	5	0.020 g	0.040 g
Kursk	5	6	0.035 g	0.050 g
Leningrad	5	6	0.035 g	0.050 g
Novovoronezh	4	5	0.0094 g	0.026 g
Rostov	6	7	0.012 g	0.068 g
Smolensk	5	6	0.025 g	0.050 g

It should be noted that the DBE and SSE values, as adopted in the Russian nuclear plant designs, are subject to change when the Russian Federation seismic zoning maps are updated, for the additional detailed seismic microzoning of the NPP deployment areas and the additional seismic microzoning of the NPP sites, as well as based on seismic monitoring data. The design basis and safe shutdown earthquake values, as given in Table 1.1, correspond to the values given in the NPP safety analysis reports as of 2011.

As required by federal standards and rules, there are three seismic stability categories identified for the NPP buildings, structures, civil works, foundations, process and electrical equipment, pipelines, instruments and other NPP systems and components, which are classified given the extent to which they are involved in ensuring safety during seismic impacts and are serviceable after the earthquake is over.

As required by federal standards and rules, seismic stability category 1 includes:

- NPP components of safety classes[1] 1 and 2;
- safety systems;
- normal operation systems and components thereof, a failure of which during seismic impacts up to the SSE inclusively, may lead to an escape of radioactive material into the NPP production rooms and into the environment in quantities beyond the values specified by the existing radiation safety standards for the design basis accident;
- the buildings and structures, as well as their foundations and parts, a mechanical damage to which during seismic impacts up to the SSE inclusively, may cause said components and systems, either by force or temperature effects, to fail;
- other systems and components, the classification of which as of falling into seismic stability category I has been justified in the design.

As required by federal standards and rules, seismic stability category II includes NPP systems and components (other than of category I), malfunctions of which, either separately or in combination with other systems and components, may cause a break in electricity and heat

[1] The classification of the NPP components in terms of impacts on safety under federal standards and rules is given in Appendix 2.

production. Seismic stability category II also includes components of safety class 3, which are not of seismic stability category I.

Seismic stability category III includes the rest of the buildings and structures, as well as foundations, civil works, components and parts of these, other than of seismic stability categories I and II.

As required by federal standards and rules, the NPP components of seismic stability category I should:

- remain capable to perform the functions involved in ensuring the NPP safety, both during and after an earthquake of the intensity up to the SSE inclusively;
- remain serviceable during and after an earthquake of the intensity up to the DBE inclusively.

As required by federal standards and rules, the NPP components of seismic stability category II should remain serviceable after an earthquake of the intensity up to the DBE inclusively.

Table 1.2 gives the geographical locations of the Russian NPP sites relative to water bodies.

Table 1.2.

Locations of Russian NPPs relative to water bodies

NPP	Water body
Balakovo	Bolshoy Irgiz and Maly Irgiz Rivers (Saratov Reservoir)
Beloyarsk	Beloyarsk Reservoir
Bilibino	Bolshoi Ponneurgen Stream

NPP	Water body
Kalinin	Udomlya Lake
Kola	Imandra Lake
Kursk	Seim River
Leningrad	Gulf of Finland (the Baltic Sea)
Novovoronezh	Don River
Rostov	Tsimlyansk Reservoir
Smolensk	interfluve of the Desna River's tributaries (the rivers Selchanka and Gnezdna)

Major conclusions from the analysis of the protectiveness against external impacts

Seismic impacts

1. The seismic stability of the NPP safety important components (equipment, pipelines, civil works, buildings and structures), including equipment of safety systems, has been confirmed:

– for components of seismic stability category I (with respect to seismic impacts of the SSE level);

– for components of seismic stability category II (with respect to seismic impacts of the DBE level).

2. The estimates made for some NPP units evidence of the available safety margins with respect to seismic impacts. For example:

− the stability for an earthquake of magnitude 7 on the MSK-64 (SSE + 1) has been demonstrated for the reactor compartment of

Leningrad-1, as well as for the safety systems built as part of the Leningrad NPP retrofit (specifically for the uninterruptible service water supply system building, and the building that accommodates the fast-acting ERCS gate valves) during their service life extension;

- the stability for an earthquake of the magnitude 7 on the MSK-64 scale (SSE + 1) has been demonstrated for the civil works of the Smolensk-1,2,3 main and spent nuclear fuel buildings;
- the stability for an earthquake of magnitude 7 on the MSK-64 scale (SSE + 2) has been demonstrated for the civil works of the building for the extra emergency feedwater system with diesel-driven pump sets, the building for the liquid radioactive waste treatment facility, and the new building for the standby diesel power station of Kola-1,2, as well as for those of the new building for the controlling safety system of Kola-3;
- for the Balakovo VVER-1000 containments, the safety margin is about 1 beyond the safe shutdown earthquake of magnitude 7 on the MSK-64 scale.

A detailed analysis of the effects from seismic impacts in excess of the maximum design values is continued.

Floods

1. No Russian NPP sites are exposed to tsunami impacts. No extreme levels of water in the water bodies, extreme weather, incidents at hydraulic works or combinations of these factors may cause a flood that would affect safety important systems and components.

Other external impacts

1. Safety of Russian NPPs has been confirmed for external natural and man-induced impacts of the intensity that requires to be taken into account in the design bases.
2. For factors other than taken into account in the design bases (e.g. aircraft crash), the designs of some Russian NPPs either include the justification that these factors cannot occur at given sites and/or demonstrate that the probability of these to occur is below the threshold value specified in the federal standards and rules, or that the consequences of these do not exceed the consequences of the events taken into account in designs.

Problems revealed

Seismic impacts

1. Not all Russian NPP units have seismic monitoring and alarm systems connected to the reactor emergency protection system. Some of the NPPs (Bilibino, Kola, Kursk and Novovoronezh) have systems introduced in just an information mode with no influence on the CPS controls.

Floods

The cooling tower makeup station of Novovoronezh-3,4 is exposed to flooding as the result of some emergencies (e.g. a dam break), which does not cause components of the systems for the heat removal to the ultimate heat sink to fail.

Other external natural and man-induced impacts

1. No turbine hall roofing strength is ensured at Novovoronezh-3,4, for the impacts of a storm wind of over 35 m/s, and no outdoor switchgear strength is ensured for the impacts of a tornado of intensity 3.2 on the Fujita scale.
2. Some of the outdoor enclosing structures at the Smolensk NPP have been found to be insufficiently resistant to the air shock wave impacts of over 1.5 kPa.

1.2.b. Information on time schedules and measures planned

A number of steps have been planned by Rosenergoatom based on the analysis of the nuclear plant degree of protection against external impacts.

Short-term steps (2012-2014):

1. A number of regular drills in the personnel response to beyond design basis accidents (including simultaneous failures at all units of multiunit NPPs) should be increased to two per year.
2. All NPPs should be fitted with engineered features for the management of beyond design basis accidents caused by external impacts and leading to the NPP blackout and/or loss of heat removal to the ultimate heat sink, including, specifically, diesel generators, diesel pumps and motor pumps, in such number as will be sufficient to ensure safety of all units of multiunit NPPs.
3. Emergency response procedures and guides should be reviewed for the sufficiency of personnel actions in the management of the accidents caused by external impacts, including for the unit that has been shut down.

4. The DBE and SSE levels should be updated for the Novovoronezh, Bilibino, Kola and Beloyarsk sites through additional seismological surveys for the NPPs, including studies regarding seismic microzoning of the NPP sites.

5. Extra estimates should be made to justify the seismic stability of the following safety important NPP components (for example, the Kola NPP’s on-shore pumping stations and service water system piping channels; some civil works of the Bilibino NPP main building and feedwater/service water system components) with additional measures developed and introduced, where required, to ensure their seismic stability.

6. Organizational and technical steps should be taken to prevent the flooding of the cooling tower makeup station at Novovoronezh-3,4.

7. Work should be completed to ensure the stability of particular structures, including:

   - the turbine hall roofing (for the impacts of a storm wind of over 35 m/s) and the outdoor switchgear (for the impacts of a tornado of the intensity 3.2 on the Fujita scale) at Novovoronezh-3,4;
   - the Smolensk NPP outdoor enclosing structures (for the impacts of an air shock wave of over 1.5 kPa).

8. The following should be undertaken for the Kola NPP units:

   - an analysis of the regularly occurring low temperature effects on the chemically desalinated water tanks outside the buildings;
   - a strength analysis for the impacts of extreme snow loads (4.6 kPa) on the safety-related buildings and structures designed to withstand

the snow load of 2 kPa, with steps taken, where necessary, to reinforce the civil works.

Mid-term steps (2014-2015):

1. Probabilistic safety analysis reports of level 1 should be complemented with analyses of natural and man-induced external impacts, including impacts of the intensity in excess of the impacts to be taken into account in the NPP design. The required technical and organizational steps should be developed based on the probabilistic safety analysis of level 1 to upgrade the protectiveness of NPPs and to improve the management of beyond design basis accidents and mitigate the consequences thereof.
2. The emergency protection system should be finally introduced at the RBMK-1000, VVER-440 and EGP-6 units to ensure their stability to seismic impacts in excess of the specified level.
3. An additional justification study should be undertaken with respect to the seismic stability of the NPP equipment, pipelines, buildings and structures based on the updates given (including due to the introduction of new federal standards and rules) to the seismic stability category for a number of safety important NPP components.

1.2.c. Preliminary or final results of the Operator's activities, including proposed future activities

The steps developed by Rosenergoatom to ensure the protection of NPPs against extreme external impacts will make it possible to:

- identify more exactly the engineering-geological conditions for siting a number of NPPs;

- finalize the justification for the seismic stability of the NPP safety important components, as well as for the stability with respect to other external factors (specifically tornadoes and extreme snow loads);
- refit the nuclear power plant units with emergency protection systems in case of seismic impacts;
- finalize the system analysis of the effects, the external impacts of the intensity greater than specified in the design basis, have on the NPP safety.

If taken, the steps planned will help taking full account of the lessons learned from the Fukushima Daiichi accident and give Russian NPPs a higher level of the protectiveness against extreme external natural and man-induced impacts.

1.3. Actions taken by the Regulator

1.3.a. Brief discussion

By way of a commission from the Russian Federation Government, Rostechnadzor conducted in March-April 2012 extraordinary inspections of the existing Russian NPPs for:

- the protectiveness safety against extreme external natural and man-induced impacts, including those of the intensity greater than the NPP design bases, and for the protectiveness against combinations of external impacts;
- the preparedness for the management of beyond design basis accidents involving full loss of the NPP in-house power;
- the preparedness for the management of accidents involving loss of the ultimate heat sink;

– the preparedness for the management of severe accidents at the NPPs (accidents involving fuel damage to beyond the design limits).

In June 2011, Rostechnadzor developed requirements to the additional analysis of the NPP protectiveness against extreme external impacts (including against earthquakes and floods) and the preparedness for the management of beyond design basis accidents, including severe ones.

In September-October 2011, Rostechnadzor arranged for the review of additional safety analysis reports submitted, including the steps planned in those to improve the safety of the NPPs, with the review results discussed with Rosenergoatom and presented to an enlarged meeting at Rostechnadzor in December 2011.

Also, the status of the Russian regulatory framework concerning the protectiveness against external impacts was reviewed by Rostechnadzor, the results of which proved it reasonable to update some of the regulatory documents regarding the requirements to:

– consideration of external natural and man-induced impacts in the NPP designs;

– the NPP site selection;

– the content of the nuclear plant safety analysis reports.

In January 2012, Rostechnadzor published the Policy Statement regarding the probabilistic safety analysis, which underlined the requirement for the PSA development with the full spectrum of initiating events encompassed, including external natural and man-induced impacts.

1.3.b. Schedules and milestones of measures planned by the Regulator

Rostechnadzor has formulated the requirements to the scope and content of the additional analysis of the Russian NPPs protectiveness safety against extreme external impacts and has given it an expert review.

Rostechnadzor supervises the taking of Rosenergoatom-developed steps based on the additional analysis of the Russian NPPs protectiveness against extreme external impacts.

Rostechnadzor plans that amendments will be made to the federal standards and rules until 2015 for the effects of extreme external impacts to be taken into account.

1.3.c. Rostechnadzor conclusions

The following conclusions have been made based on results of the nuclear plant protectiveness assessment with respect to external natural and man-induced impacts:

1. The requirements of the federal standards and rules for the protectiveness against external impacts are observed for the Russian NPPs.
2. The short-term, mid-term and long-term steps developed by Rosenergoatom to ensure the protection of the NPPs against external impacts have been justified and are sufficient and are under the control of Rostechnadzor.
3. Based on results of the assessments made, it has been found necessary to update the Russian standards increasing the requirements to the NPP site selection, the NPP seismic stability and consideration of external (natural and man-induced) impacts in the NPP design.

4. The safety issues revealed in the additional safety analysis do not indicate to a low or inadmissible safety level of the Russian NPPs.

1.4. Summary table

The table below gives a summary of reported items 1.2.a, 1.2.b, 1.2.c, 1.3.a, 1.3.b and 1.3.c (Topic 1. External Events) concerning issues of the Russian NPP intrinsic safety against external natural and technological impacts.

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 1.2.a) Completed? Ongoing? Planned?	(Item 1.2.b) Schedule or milestones for planned activities	(Item 1.2.c) Results available Yes? No?	(Item 1.3.a) Completed? Ongoing? Planned?	(Item 1.3.b) Schedule or milestones for planned activities	Conclusion available Yes? No?
Inspection of all Russian NPP	Completed	Completed in 2011	Yes	Taken	Completed in 2011	Yes
Express review of the NPP protection	Completed	Completed in 2011	Yes	Expert review completed	Completed in 2011	Yes
Additional analysis of the Russian NPP protectiveness against external impacts	Completed	Completed in 2011	Yes	Expert review completed	Completed in 2011	Yes
Increasing the number of regular drills in personnel response to beyond design basis accidents	Ongoing	Not less than 2 drills per year planned	Yes			
Additionally fitting the NPPs with engineered features for management of beyond-design-basis accidents	Ongoing	Until 2014	Yes			
Review of the emergency response procedures and guides for the adequacy of personnel accident management actions	Ongoing	Until 2014	Yes			

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 1.2.a) Completed? Ongoing? Planned?	(Item 1.2.b) Schedule or milestones for planned activities	(Item 1.2.c) Results available Yes? No?	(Item 1.3.a) Completed? Ongoing? Planned?	(Item 1.3.b) Schedule or milestones for planned activities	Conclusion available Yes? No?
In-depth study into the effects of impacts in excess of the maximum design values and into the impacts on the NPP safety important components, as justified by regulations	Ongoing	Until 2014	Yes			
Update of the DBE and SSE levels via extra seismological surveys	Ongoing	Until 2014	Yes			
Finalizing the analysis of the stability to external natural impacts for a number of the NPP safety important components	Ongoing	Until 2014	Yes			
Probabilistic safety analysis of level 1 for external natural and man-induced impacts	Planned	Until 2016	Yes			
Additionally fitting the NPPs with emergency protection systems against seismic impacts in excess of the specified level	Ongoing	2015	Yes			
Additional feasibility study for the seismic stability of the NPP components, pipelines, buildings and structures based on the updates given (including due to the introduction of new standards and rules) to the seismic stability category for a number of NPP safety important components	Planned	Until 2015	Yes			

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 1.2.a) Completed? Ongoing? Planned?	(Item 1.2.b) Schedule or milestones for planned activities	(Item 1.2.c) Results available Yes? No?	(Item 1.3.a) Completed? Ongoing? Planned?	(Item 1.3.b) Schedule or milestones for planned activities	Conclusion available Yes? No?
Adoption of the Policy Statement with respect to probabilistic safety analysis				Completed	Completed in 2012	Yes
Making amendments to the federal nuclear standards and rules	Participation planned	Until 2015	Yes	Planned	Until 2015	Yes
Supervision of the taking of the safety upgrading steps by Rosenergoatom				Ongoing	Until 2017	Yes

2. Topic 2. Design issues

2.1. Brief discussion of the topic

Federal standards and rules formulate the purpose of beyond design basis accident management as returning a NPP unit into controlled state when chain fission reaction is stopped, continuous fuel cooling is provided and radioactive materials are confined within the prescribed boundaries.

The federal standards and rules regulate the following: approach to selection of a list of beyond design basis accidents in the NPP safety case, their scenarios, requirements for justification of accident management measures, of their effectiveness and sufficiency. Reference lists of the beyond design basis accidents, including initiating events, progression sequences and consequences for each reactor type are provided in a number of regulatory documents. Reference lists of beyond design basis accidents to be analyzed are contained in a number of federal standards and rules. These lists include the accident with NPP blackout and loss of ultimate heat sink. Final lists of the beyond design basis accidents, their best-estimate (non-conservative) analysis with assessment of probabilities of occurrence of different accident progression sequences and consequences, along with the analysis of safety system operation are to be determined in the NPP design documentation and presented in the NPP safety analysis report.

The analysis of consequences of beyond design basis accidents presented in the NPP design serves as a basis for development of action plans to protect the personnel and the public in case of accidents and for development of a beyond design basis accident management guide.

The design bases of the Russian NPPs with VVER and RBMK reactors were reviewed in details earlier in the framework of IAEA extrabudgetary projects. The recommendations made during the reviews were taken into account while developing and implementing NPP safety enhancement measures.

As of March 2011, three Russian NPPs were equipped with additional engineered systems intended for management of beyond design basis accidents with complete station blackout. These systems include mobile diesel generator station at Kola NPP, mobile diesel generator station at Novovoronezh NPP, and gas turbine facility at Bilibino NPP. It should be mentioned that at the Russian NPPs there are aerial and cable power transmission lines connecting different power units enabling in-house power supply from neighboring operational units.

In the framework of additional analysis of protection of the Russian NPPs against extreme external impacts, analysis of beyond design basis accidents with loss of in-house power (plant blackout) and/or loss of heat removal from the reactor installation, spent fuel pools and spent fuel storage facilities to the ultimate heat sink was performed.

A plant blackout accident implies loss of off-site power supply, on-site normal operation power sources and the emergency power supply sources (diesel generators).

Loss of ultimate heat sink means loss of heat removal from reactor cores, spent fuel pools, SNF storage facilities to the ultimate heat sink – atmosphere or water body (sea, lake, cooling pond, river), which is facilitated at the Russian NPPs by special heat removal systems: service water system, circulation water system, secondary circuit heat removal system etc. In case of an accident with loss of ultimate heat sink from the reactor core, fuel rods overheat and the accident evolves into a severe stage unless special accident management actions are taken.

In accordance with the federal standards and rules, design of each NPP unit includes an emergency power supply system including switching and multiplexing, transforming and distribution equipment and emergency power supply sources - diesel generators and storage batteries.

A number of channels of the emergency power supply system depends on the number of safety trains supplied by them. According to the requirements of federal standards and rules, the emergency power supply channels must be physically segregated and functionally isolated. According to the aforementioned requirements, all the power consuming equipment is classified into three groups – group one, group two, and all other power consumers.

The first group consumers are supplied with power from storage batteries through a DC power supply circuit (DC cabinets and racks), and through AC power supply system (invertors). No interrupts of power is allowable for this category of power-consuming equipment.

The consumers of the second category are supplied with power through AC busbars that are normally energized from the normal operation power supply sources, and are switched to emergency diesel generators in case of loss of off-site power. The interrupts in the power supply for this category of equipment are allowable for the period of start-up and sequencing of diesel generators.

Other equipment does not have emergency power supply and lose power in case of loss of normal power supply sources of the plant.

The startup and loading sequence takes 15 to 90 seconds from the moment of initiation of the signal to start up the diesels at different Russian NPPs. The minimal level of fuel supply at NPPs is sufficient for 2 days of continuous simultaneous operation of all diesel generators at nominal power. Typical time of discharge of the storage batteries of the emergency power supply systems in case of loss of off-site power accompanied by loss of diesel generators amounts to 1-2 hours.

Normally, Russian NPPs are connected to the grid via electricity transmission lines of two different voltages through outdoor switchyards that can be interlinked. The exceptions are Bilibino NPP connected to the grid with the electricity transmission lines of the same voltage through an indoor switchgear, as well as Kola, Kursk and Novovoronezh NPPs connected to the grid via electricity transmission lines of three different voltages. In-house power supply is provided by the work power transformers or auxiliary transformers connected to the switchyard. Some NPP have possibilities of connection to alternative power sources (e.g., Narva hydro plant for Leningrad NPP).

Emergency power supply systems of the units of operational Russian NPPs have three independent channels, with the exception of Novovoronezh NPP (two channels at the Units 3 and 4) and Leningrad NPP (four channels at the Units 3 and 4), each of them including one or more diesel generator station of various powers. At some sites, there are so-called shared plant-level DG stations that are not part of emergency power supply channels and can be connected, whenever necessary, to one of the channels of any power unit in case of loss of in-house power supply and be used as beyond design basis accident management tools.

The accomplished analysis confirmed adequate protection of the Russian NPPs against external impacts to be taken into account in the design bases of NPP. However, for some of the operational NPPs heat removal from the reactor cannot be provided for unlimited time after loss of in-house power supply.

The exceptions are the units of Bilibino NPP (having low power reactor cores with low power density), as well as the units of Kola and Novovoronezh NPPs equipped with the engineered systems for management of beyond design basis accidents with station blackout. These systems include mobile diesel generator station and additional system supplying water to steam generators with the aid of diesel-driven pumps at Kola NPP (Figs. 2.1 and 2.2.), and mobile emergency diesel generator station at Novovoronezh NPP (Fig. 2.3).

Fig. 2.1. Mobile emergency diesel-generator station, Kola NPP

Fig. 2.2 Emergency diesel-driven pump of the system for additional emergency water supply into steam generators of Kola NPP

Fig. 2.3. Mobile emergency diesel-generator station, Novovoronezh NPP

A mobile diesel generator was supplied to Kola NPP in 1997. Novovoronezh NPP has been equipped with a mobile diesel generator since 2003. The additional system supplying water to steam generators with the aid of diesel-driven pumps was implemented at Kola NPP in 2001.

The parameters of the in-house power supply systems of different Russian NPP power units and the list of the engineered systems available at the plants for station blackout accident management are provided in Appendix 3.

Heat removal to the ultimate heat sink (when the units are shutdown) is performed at the Russian NPP units by one of the following methods.

Heat removal from the cores of the VVER-440 and VVER-1000 reactors

Fig. 2.4 illustrates the process diagram of heat removal to the ultimate heat sink for VVER reactor plants.

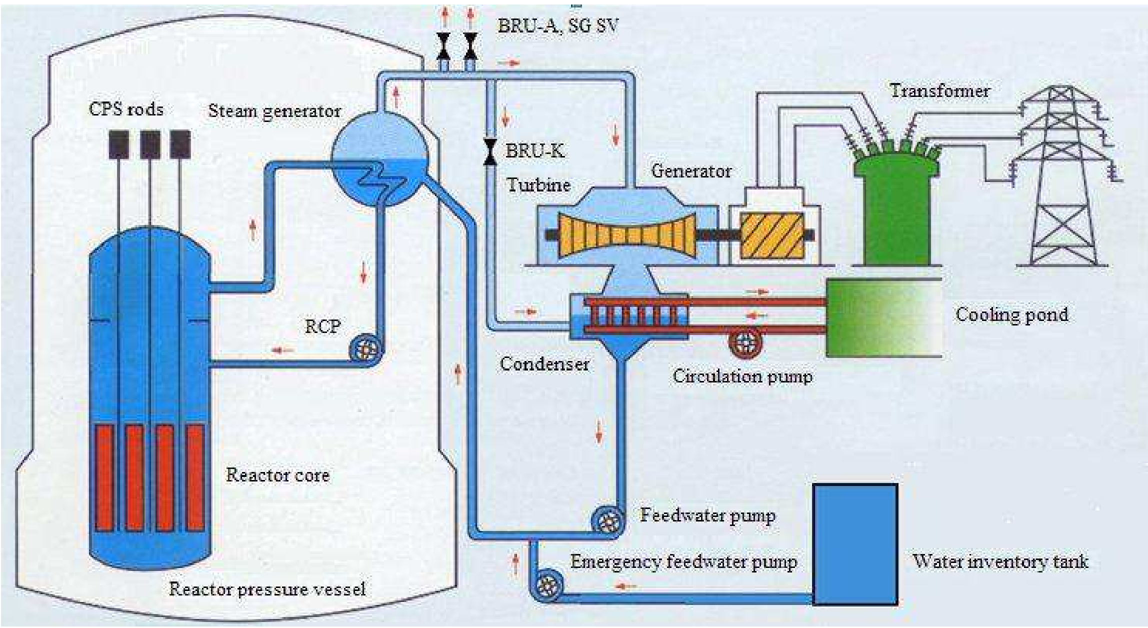

Fig. 2.4. Process diagram of heat removal to ultimate heat sink for NPP with VVER units

(design without cooling towers)

During normal operation and operational events, including accidents, heat is removed from the primary circuit to the secondary circuit coolant via steam generators. The water of the secondary circuit is supplied to SG, where, having received heat from the primary circuit, it converts to steam. The steam is dumped to the turbine condensers, where it condenses and transfers heat to the circulation water, which removes heat to the ultimate heat sink – to atmosphere through cooling towers for the units with cooling towers, or to the water of the cooling pond for the units without cooling towers.

In the normal cooling mode (only for VVER-1000), the primary coolant with the aid of normal cooldown system transfers heat to the essential service water system, which further transfers it to the atmosphere (ultimate heat sink) with the aid of spray pools. If there are no spray pools, heat is removed from the service water system to the cooling pond (ultimate heat sink) with the aid of heat exchangers.

During accidents, heat can be removed through the secondary circuit to atmospheric air by means of dumping the secondary coolant through steam safety valves (steam dump valves to atmosphere BRU-A, SG safety valves). Water can be supplied to steam generators from external sources (fire trucks, diesel-driven pumps etc.). Feed and bleed process can be used for cooling, when water is supplied from the make-up system (or from ECCS) to the primary circuit, and the water heated in the core is released through the safety valves of the pressurizers into the pressure suppression (bubbler) tank and then into the containment. After that, the water passes through heat exchanges and transfers heat to service water, wherefrom it is transferred to the ultimate heat sink.

Heat removal from the cores of the RBMK-1000 reactors

Fig. 2.5 illustrates the process diagram of heat removal to the ultimate heat sink for RBMK reactor plants.

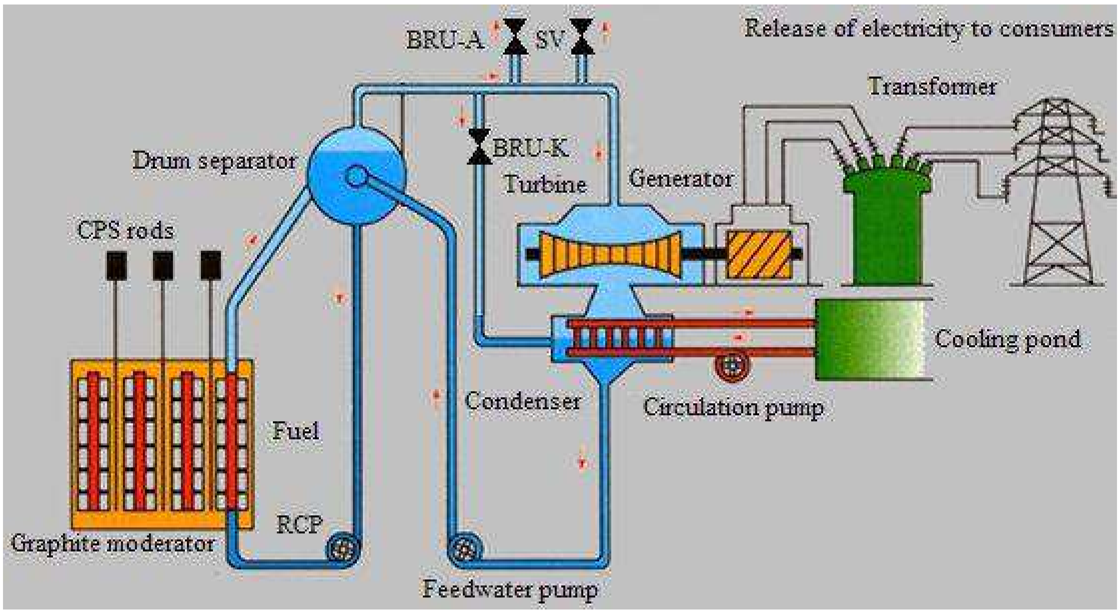

Fig. 2.5. Process diagram of heat removal to ultimate heat sink for NPP with RBMK-1000 units

In the cooling mode, excess steam from the drum separators is directed through turbine bypass valves (BRU-K) to turbine condensers cooled with circulation water, which transfers heat to the ultimate heat sink – cooling pond.

If turbine condensers are unavailable, heat removal is performed in the open cycle, when feedwater is injected in the reactor and steam is released from the drum separators via the main relief valve into the accident localization system compartments. Heat from the accident localization system is removed by service water through heat exchangers to the water of the cooling pond (ultimate heat sink).

Air cooling of the RBMK reactor units is possible with the aid of natural circulation of air entering the drum separator compartments through dislodge (blow-out) panels. The principal diagram of air cooling of RBMK reactor units is illustrated by the Fig. 2.6.

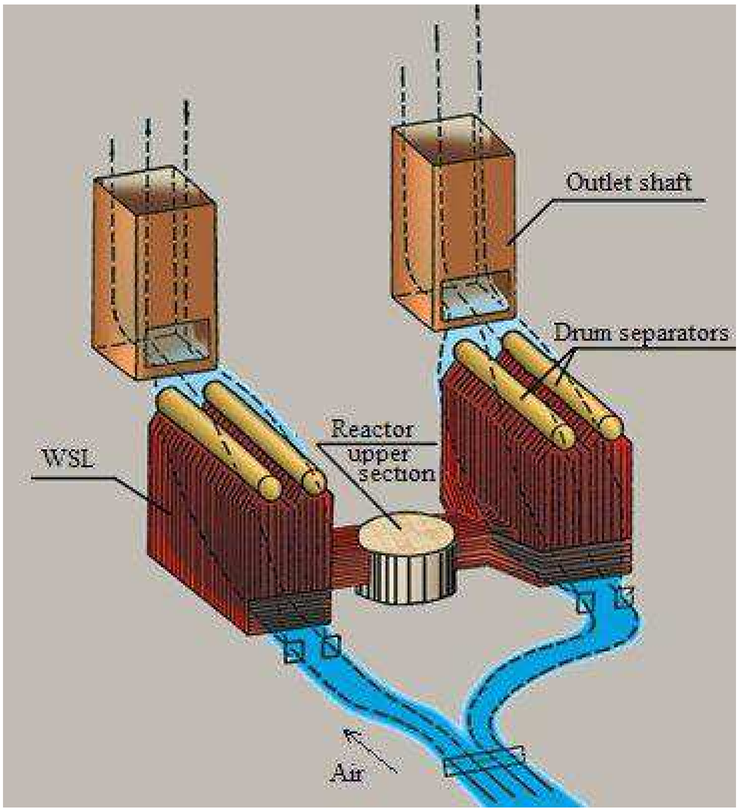

Fig. 2.6. Principal diagram of air cooling of RBMK reactor units

Heat removal from the core of the BN-600 reactors

During normal and emergency cooling of the reactor, emergency core cooling system is in operation removing heat with the use of water inventory of the circulation (third) circuit and of the pure condensate tanks. In the steam mode of operation of the steam generators, steam is dumped to atmosphere, after transition of the steam generators into water operation mode water is circulated in the third circuit through turbine condensers and deaerators.

Fig. 2.7 illustrates the process diagram of heat removal to the ultimate heat sink for Beloyarsk NPP with a BN-600 reactor.

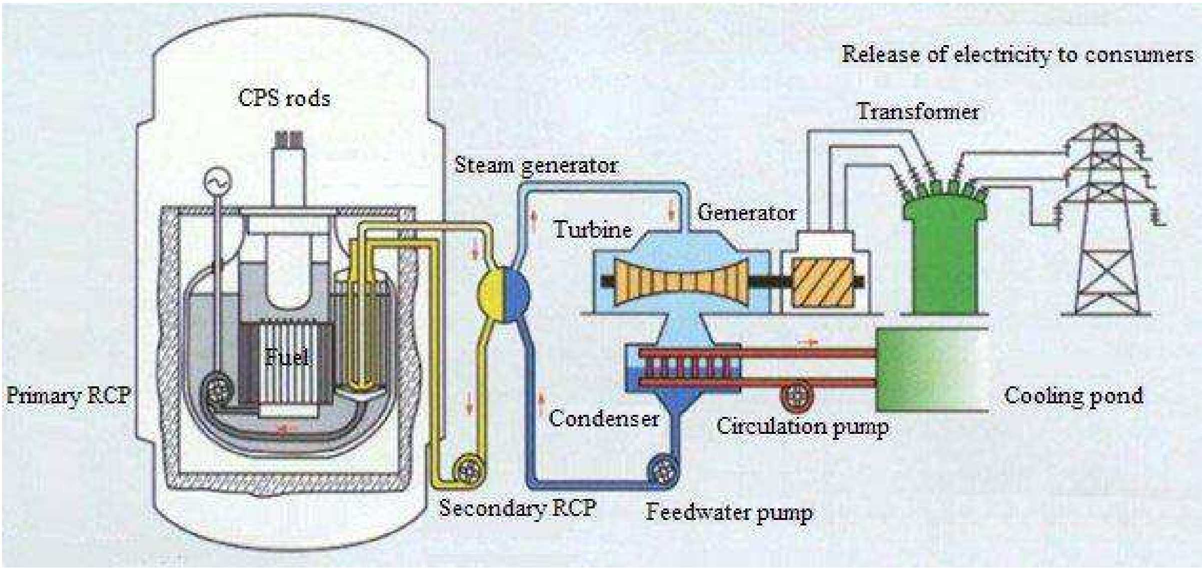

Fig. 2.7. Process diagram of heat removal to the ultimate heat sink for Beloyarsk NPP with BN-600 reactor

Presently, an additional reactor cooling system is installed to cool the reactor via air heat exchanger connected to the secondary circuit. This system can be used in case of failure of the emergency cooling system. The system is capable of maintaining heat balance in the core for unlimited period of time. Fig. 2.8 illustrates the process diagram of heat removal to atmosphere via air heat exchanger for Beloyarsk NPP with BN-600 reactor.

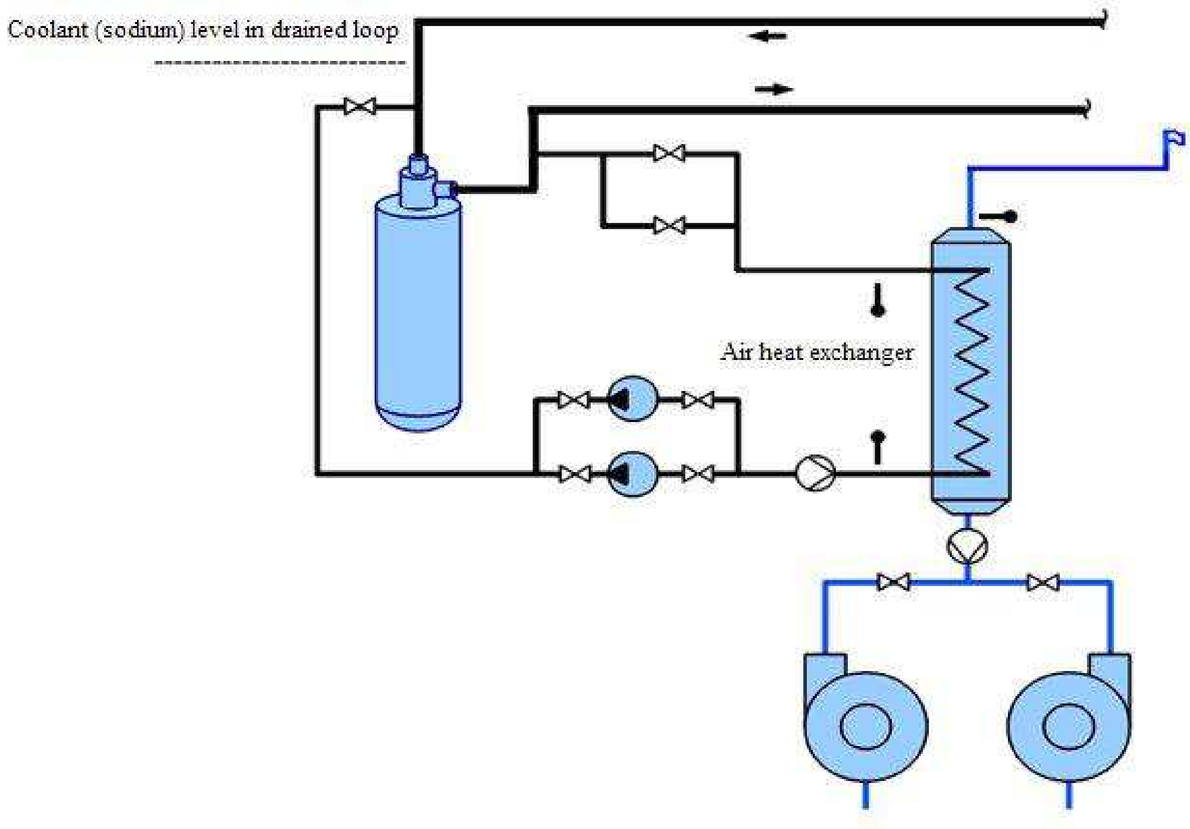

Fig. 2.8. Diagram of the additional emergency cooling system with air heat exchangers

Heat removal from the cores of the EGP-6 reactors

Heat removal from the reactor in the shutdown mode is performed by the maintenance cooling system. Residual heat is transferred to service water in the maintenance heat exchanger. Service water is cooled on air-radiator heat exchangers and transfers heat to atmosphere (the ultimate heat sink). Fig. 2.9 illustrates the process diagram of heat removal to the ultimate heat sink for Bilibino NPP with EGP-6 reactor.

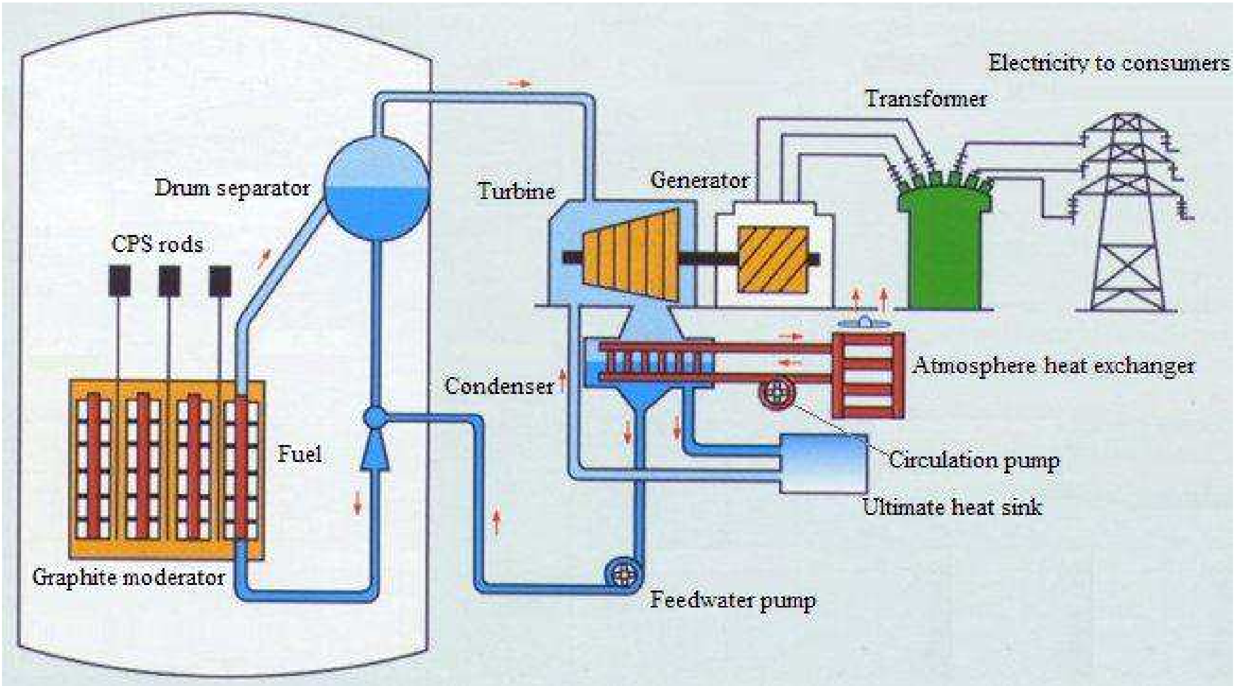

Fig. 2.9. Principal diagram of heat removal to ultimate sink for EGP-6 reactors.

Heat removal from spent nuclear fuel storage facilities

Spent fuel pools are equipped with the systems needed to ensure their safe operation, including the following:

- systems for draining and filling the spent fuel pool;
- systems for monitoring, collection and return of leaks;
- make-up system;
- emergency make-up system;
- radiation monitoring system;
- ventilation system;
- water clean-up system.

Water is cooled with the cooldown system transferring heat to service water, which, in its turn, transfers heat either to atmosphere (at the plants equipped with spray pools or air radiator coolers), or to the cooling pond (ultimate heat sink). The cooling system includes several redundant channels.

Filtering equipment of the spent fuel pool ventilation system is designed and operated so as to limit potential release of radionuclides and radioactive aerosols.

Appendix 4 contains more detailed information about the methods of heat removal to the ultimate heat sink used at the Russian NPPs with different reactor types.

High level of safety of new NPPs is achieved by using a combination of passive and highly reliable active safety systems, redundancy and separation of the systems important for safety. So-called "core melt trap" (AES-2006 design) can be quoted as an example of new development in this area. The system for localization of core melt is located under the reactor core. For example, heat removal from the reactor to the ultimate heat sink in the AES-2006 design is achieved by passive heat removal system.

Operator actions intended to manage beyond design basis accidents with plant blackout or with loss of ultimate heat sink are prescribed by beyond design basis accident management guides. The beyond design basis accident management guides provide guidance on restoring major safety functions, including heat removal to the ultimate heat sink.

2.2. Actions taken by the Operator

2.2.a. Overview of the actions taken or planned by the Operator

In March–April 2011, Rosenergoatom conducted audits of all operational NPPs, one of the topics of which was preparedness to manage beyond design basis accidents, inclusively those associated with plant blackout or loss of the ultimate heat sink, along with additional analysis of the plant design bases.

In June-August 2011, Rosenergoatom conducted additional analysis of protectiveness of the Russian NPPs to external impacts, including:

- analysis of preparedness to management of an accident with complete loss of power at all units of a multiunit NPP;
- analysis of preparedness to manage of an accident with loss of systems for heat removal to ultimate heat sink at all units of a multiunit NPP.

The analysis consisted of the following steps:

- determination of the accident progression stages with assessment of time of initiation of each stage and definition of the parameters characterizing each stage;
- verification of existence of specific instructions to the personnel in the emergency operation procedures and accident management guides concerning restoration of heat removal functions in case of accidents with plant blackout and/or loss of heat removal;
- assessment of adequacy of the existing engineered systems and organizational measures to manage accidents, including the cases where the accident affects several power units of a multiunit NPP, and the on-site spent nuclear fuel storage facility.

During the analysis, Rosenergoatom was using the NPP design documentation and the results of additional assessments made by the design institutes.

The main conclusions of Rosenergoatom concerning the results of analysis of preparedness of the Russian NPP to manage the accidents with station blackout and/or loss of heat removal to ultimate heat sink.

1. Preparedness of the Russian NPPs for beyond design basis accident management is ensured by the design solutions and by the existence of special engineered systems and beyond design basis accident management guides produced for all NPP units.
2. Preparedness of the Russian NPPs to manage beyond design basis accidents is supported by the personnel training system, including the use of full-scope simulators for training operators to act during beyond design basis accidents.
3. In case of station blackout or loss of heat removal to ultimate heat sink, NPP personnel has adequate period of time to restore in-house power supply from the grid, and to restore operability of at least one emergency power supply channel in order to prevent development of the accident into severe stage.
4. In case of failure of personnel to take accident management actions, the accident evolves through the following stages:

for VVER-1000/ VVER-440 reactor plants:

- decrease in the steam generator level to the values at which primary circuit heat-up causes opening of the pressurizer relief valves (~2/4 hours for VVER-1000/VVER-440, respectively, after the moment of loss of off-site power);

- decrease in the level in the reactor, heating of fuel element cladding, transition of the accident into severe stage (~3/9 hours after loss of off-site power for VVER-1000/VVER-440, respectively);

for RBMK-1000 reactor plants:

- steam removal from drum separators through the existing steam relief valves or through the main safety valve into the accident localization system compartments;
- decrease of the level in the fuel channels, heating of fuel element cladding, transition of the accident into severe stage (~6 hours after loss of off-site power);

for BN-600 and EGP-6 reactor plants:

- the accident does not develop into severe stage, heat is removed by the air cooling systems, in ~55 hours for BN-600 and ~6 hours for EGP-6 heat removal from the reactor unit fully compensates residual heat generation;

for SNF storage facilities and spent fuel pools:

- the accidents evolve through the stages of heat-up of cooling water, its evaporation, decrease of water level to the value at which fuel starts overheating, whereafter the accidents transitions into severe stage; the available time period in case of blackout at NPPs with different reactors is up to several days.

5. Russian NPPs in the European part of the country have diversified connections to the grid. Based on the available statistics of the events with loss of off-site power, assessment of probability of recovery of the off-site power was made. According to the estimate, a likelihood of

recovery of the off-site power within 1 hour is 90%, within 4 hours - 99%. Bilibino NPP, located away from the European grid system, in case of plant blackout should remain in the safe state without transitioning of the accident into severe stage for practically unlimited time.

6. The existing arrangements for sharing the equipment of NPP power units allow using the equipment of the neighboring power units in order to provide power supply and heat removal to the ultimate heat sink.

Issues identified

1. Additional accident management systems need to be implemented at a number of Russian NPPs for the accidents with long-term station blackout and/or long term unavailability of the systems for heat transfer from the reactors and SNF storage facilities to the ultimate heat sink.
2. Personnel requalification training programs do not include the drills to practice operator actions in case of beyond design basis accidents affecting several units simultaneously.
3. For some of the units of the Russian NPPs, the existing beyond design basis accident analysis requires the list of scenarios for analysis to be refined. The lists of initiating events and states of the units for the existing probabilistic safety analysis need to be extended.

A possibility of long term (24 hours and more) loss of off-site power and/or long term loss of heat removal to the ultimate heat sink, inclusively at several units of a multiunit NPP simultaneously, is not taken into account in the probabilistic and deterministic safety analysis of the Russian NPPs.

2.2.b. Information about time schedules and measures planned

Based on the results of analysis of NPP preparedness to manage beyond design basis accidents, Rosenergoatom planned the following steps.

Short-term steps (2012-2014):

1. Supply and install at the Russian NPPs additional equipment to manage beyond design basis accidents with plant blackout and/or loss of heat removal to ultimate heat sink, namely: additional engineered systems that can be used to supply power to the systems important for heat removal, including mobile power supply sources, as well as mobile motor-driven pumps, standpipes, tank-trucks; additionally equipped stations for pumping cooling water out of cooling ponds, water bodies or tanks providing a possibility of arranging alternative water supply to cool reactors (steam generators), spent fuel pools, spent fuel storage facilities in order to preclude development of beyond design basis accidents with plant blackout and/or loss of heat removal to ultimate heat sink into severe stage.
2. Implementation of measures to increase reliability of communication systems in case of station blackout, in particular:
   - implementation of unified radio communication system of NPP;
   - creation of mobile reserve land-based satellite communication systems;
   - renovation/implementation of mobile control centers for the management of accident management activities and for the manager of the emergency response group supporting nuclear power plants.

3. Analytical and experimental justification of the possibility of passive (air) core cooling of RBMK reactor plants.
4. Implementation of the measures to minimize the amount of spent nuclear fuel on NPP sites:
   - commissioning of the spent nuclear fuel dismantling and storage facilities at Leningrad, Kursk and Smolensk NPPs;
   - sending SNF for long term storage.

Mid-term steps (2015-2017):

1. Completion of the necessary modernization of the normal operation power supply system and emergency power supply system in order to increase reliability of the in-house power supply (e.g., replacement of thyristor transducers and reversible motor-driven generators for static converters, replacement of the existing storage batteries for higher capacity storage batteries, cross-connecting power distribution systems (switchgears) in order to provide mutual backup etc.).
2. Additional measures are scheduled at several plants in order to increase the reliability of the in-house power supply from the grid, along with the measures to implement additional cooling systems for diesel generators that can be used in case of loss of preferred DG cooling systems.
3. Equipping all NPPs with the engineered systems allowing to make up the existing tanks and vessels in case of loss of heat removal to ultimate heat sink. In particular, renovation of the system of ring-type fire pipeline, arranging points for connection of fire trucks and tanks – at all NPPs.

4. Development and implementation of alternative systems for water supply into reactor cores (for RBMK reactor plants) and into spent fuel pools.
5. Extending and refining beyond design basis accident analysis, completion of level 1 probabilistic safety analysis taking into account external impacts and the engineered systems implemented at the plants, inclusively taking into account the possibility of accidents simultaneously affecting several units of multiunit plants.
6. Improvement of beyond design basis accident management guides in relation to accident management actions for the accidents with a plant blackout and/or loss of heat removal taking into account the possibility of accidents simultaneously affecting several units of multiunit plants.

Long-term steps (until 2025):

Arranging for transportation of SNF of the Unit 1 and 2 of Beloyarsk NPP for long term storage.

2.2.c. Preliminary or final results of the Operator’s activities, including proposed future actions

Implementation of the measures developed by Rosenergoatom to ensure preparedness of the Russian NPPs to manage the accidents with plant blackout and/or loss of heat removal to the ultimate heat sink should allow decreasing the risk of development of beyond design basis accidents, including those affecting all units of a multiunit NPP, into severe accidents.

2.3. Actions taken by the Regulator

2.3.a. Brief discussion

In March-April 2011, Rostechnadzor performed unscheduled inspections of the design bases of the operational Russian NPPs, including the following aspects:

- a degree of protection of the NPPs against extreme external events of natural and man-induced origin, including the impacts with the intensity exceeding the NPP design bases and combinations of external events;
- preparedness for management of beyond design basis accidents with complete loss of NPP in-house power supply;
- preparedness for management of accidents with the loss of ultimate heat sink.

In September-October 2011, Rostechnadzor organized a review of the reports containing results of the analysis of protectiveness of the Russian NPPs against extreme external impacts. The results of the review were discussed with Rosenergoatom and designer organizations.

Simultaneously with the review of additional protectiveness analysis of the Russian NPPs against extreme external impacts, the regulatory documentation related to beyond design basis accident management was analyzed. The analysis revealed the expediency of improvement of the documents in relation to the requirements for beyond design basis accident management.

2.3.b. Time schedules and milestones of activities planned by the Regulator

Rostechnadzor controls the progress of implementation of the measures planned by Rosenergoatom based on the results of the analysis of protectiveness of the Russian NPPs against extreme external impacts (according to the schedules of implementation of the measures to increase protection of power units against extreme external impacts adopted by Rosenergoatom and approved by Rostechnadzor).

In the period of 2012-2015 Rostechnadzor intends to make necessary amendments to the federal nuclear standards and rules establishing additional requirements for safety justification documents and beyond design basis accident management guides.

2.3.c. Rostechnadzor conclusions

The following main conclusions were made concerning the accomplished assessment of preparedness of the Russian NPPs to manage beyond design basis accidents, (including the accidents with plant blackout and/or loss of heat removal to ultimate heat sink).

1. The federal nuclear standards and rules are complied with by the Russian NPPs.
2. Rostechnadzor believes that the design solutions and measures suggested by Rosenergoatom in order to ensure adequate protectiveness of NPPs against external events are reasonable and sufficient. Implementation of the short-term, mid-term and long-term measures suggested by Rosenergoatom in order to ensure an adequate degree of protection of NPPs against external impacts is under control of the state safety regulatory authority.

3. Rostechnadzor deems necessary to refine the Russian regulatory guidelines during the period of 2012-2015 in order to detail the requirements for beyond design basis accident management and analysis, as well as for the development of the beyond design basis accident management guidelines.

4. The safety issues identified during the additional analysis are not indicative of inadequate or unacceptable safety performance of the Russian NPPs.

2.4. Summary Table

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(2.2.a) Accomplished? In progress? Planned?	(2.2.b) Schedule or major milestones of the planned activities	(2.2.c) Results available: Yes? No?	(2.3.a) Accomplished? In progress? Planned?	(2.3.b) Schedule or major milestones of the planned activities	(2.3.c) Conclusions available: Yes? No?
Inspection of all Russian NPP	Accomplished	Accomplished in April 2011		Accomplished in April 2011	Accomplished in April 2011	Yes
Express-analysis of the NPP protectiveness	Accomplished	Accomplished in 2011	Yes	Accomplished	Accomplished in 2011	Yes
Additional analysis of resistance against external events and preparedness to manage BDBAs at all Russian NPPs	Accomplished	Accomplished in 2011	Yes	Accomplished	Accomplished in 2011	Yes
Increase in the number of regular emergency drills of NPP personnel to practice BDBA management actions	Performed continuously	Planned at least twice a year	Yes			
Supplying and installing additional engineered systems for BDBA management in the amount sufficient to ensure safety of all units of multiunit NPPs	In progress	Until 2014	Yes			
Analysis of emergency operating procedures for	In progress	Until 2014	Yes			

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(2.2.a) Accomplished? In progress? Planned?	(2.2.b) Schedule or major milestones of the planned activities	(2.2.c) Results available: Yes? No?	(2.3.a) Accomplished? In progress? Planned?	(2.3.b) Schedule or major milestones of the planned activities	(2.3.c) Conclusions available: Yes? No?
sufficiency of operator actions to manage accidents						
Implementation of measures to increase reliability of communication systems in case beyond design basis accidents	In progress	Until 2015	Yes			
Development and implementation of alternative systems for water supply into reactor core of RBMK	Planned	Expected to be accomplished in 2017	Yes			
Extension and refinement of BDBA analysis and refinement of level 1 PSA taking into account external events and engineered systems implemented at the NPP units	In progress	Expected to be accomplished in 2016	Yes			
Implementation of the measures to minimize the amount of spent nuclear fuel on NPP sites	In progress	Until 2021	Yes			
Adopting the PSA Policy Statement				Accomplished in 2012	-	Yes
Amendment of the federal nuclear standards and rules	Participation planned	Until 2015	Yes	Planned	Expected to be accomplished in 2015	No
Control of implementation of the measures developed by Rosenergoatom based on the results of additional analysis				In progress	Expected to be accomplished in 2021	No

3. Topic 3. Severe accident management and recovery (on site)

3.1. Brief discussion of the topic

In the Russian regulatory documents, severe accidents are understood as a beyond design basis accident with fuel rods damage in excess of the maximum design limit, which can be accompanied by maximum permissible emergency release of radioactive materials into the environment.

The issues of management of beyond design basis accidents, including severe stage, are regulated by the federal nuclear standards and rules, according to which the safety of the Russian NPPs is ensured by means of consistent implementation of the defense-in-depth concept. The defense-in-depth concept is based on the use of a system of physical barriers on the way of propagation of ionizing radiation and radioactive substances into the environment and of the system of engineered and organizational measures to protect the barriers and maintain their efficiency, as well as to protect the personnel, the public and the environment.

The designs of each unit of the Russian NPPs include a list of beyond design basis accidents, their classification in terms of frequency of occurrence and severity of the consequences, including scenarios leading to fuel damage.

The defense-in-depth concept is implemented at all Russian NPPs, according to which beyond design basis accident management measures are anticipated at every plant. Additional technical measures (to manage severe accidents) must be implemented in case if a frequency of occurrence of the maximum permissible emergency release exceeds 10^{-7} 1/year.

Organizational measures and engineered systems for accident management existing in the designs of the operational NPPs in Russia are designed for preventing development of design basis accidents into beyond design basis accidents and of beyond design basis accidents into severe stage.

The operating personnel's actions in case of beyond design basis accidents are regulated by the beyond design basis accident management guides. All available and operable equipment and engineered systems are used for such actions.

At some Russian NPPs, organizational measures and engineered systems required for severe accident management have been implemented, including the following:

- flammable gas concentration monitoring system and hydrogen explosion protection system;
- severe accident management guidelines for Balakovo NPP;
- symptom-oriented emergency operating procedures.

3.2. Actions taken by the Operator

3.2.a. Overview of the actions taken or planned by the Operator

After the accident at Fukushima-Daiichi NPP, Rosenergoatom performed additional assessment of preparedness of the Russian NPPs to manage severe accidents. Rosenergoatom assessed the preparedness of the Russian NPPs to manage severe accidents caused by long term loss of fuel cooling in reactor cores, spent fuel pools and SNF storage facilities.

In the course of the analysis of preparedness of the Russian NPPs to manage severe accidents based on ENSREG approach, Rosenergoatom focused its attention on the following aspects:

sufficiency of the existing organizational measures and engineered systems required for severe accident management, including the following:

- ensuring residual heat removal;
- ensuring controlled depressurization of the reactor;
- ensuring controlled filtered depressurization of the containment;
- ensuring hydrogen concentration monitoring and hydrogen removal from the containment;
- availability and sufficiency of the instrumentation and controls designed to operate in the conditions of beyond design basis accident;
- availability of severe accident management guidelines;

the degree of knowledge of phenomenology of severe accidents (representativity of the severe accident scenarios considered in the safety analysis reports from the standpoint of planning emergency response actions, assessment of conditions of physical barriers of NPP units at different stages of development of severe accidents);

availability of computer codes for severe accident analysis.

In the framework of additional analysis of protectiveness of the operational NPP units with VVER reactors, Rosenergoatom performed an analysis of in-pile stage of severe accidents caused by long-term plant blackout. According to the estimates made, the time to reactor vessel damage in case of absence of accident management actions amounts to about 6 hours for VVER-1000 and about 30 hours for VVER-440 reactor plants.

For all NPPs with VVER reactors equipped with the containment hydrogen monitoring and removal systems, an analysis was performed to verify adequacy of the capability of these systems to preclude formation of explosive gas mixtures in case of the most unfavorable scenarios during in-pile stages of severe accidents.

An analysis of the accidents with loss of cooling of the spent fuel pools was performed for all units with VVER reactors. According to the estimates made, the minimal time to dry-out of a fuel cladding surface (without taking credit for actions to restore spent fuel pool cooling) amounts to about 20 hours for VVER-1000 and at least 30 hours for VVER-440 reactor plants.

For RBMK units, an assessment of adequacy of the existing design solutions for maintaining integrity of the reactor cavity (structural component of the reactor installation), as well as of the rooms containing pipelines, which are beyond the boundaries of leak-tight compartments (most of the large diameter pipes of RBMK units are contained within such boundary) was performed. The results of the assessment evidence that:

– reactor cavity integrity can be maintained by means of operation of steam relief valves damping steam-gas mixture into the accident localization system. These valves can be operated automatically or manually in case of station blackout;

– integrity of leaktight compartments in case of pressure buildup within them is maintained by means of operation of safety (relief) valves that can be operated automatically or manually in case of station blackout;

– integrity of the rooms containing pipelines beyond the boundaries of leaktight compartments is maintained by means of dislodge panels existing in the drum separator compartments.

At the power units with RBMK reactors, there is a possibility to remove heat from the reactor core at the expense of passive air cooling of the steam-water pipelines in the drum separator compartments after actuation of dislodge panels. According to the estimates made, such air cooling is capable of removing the generated residual heat after 5-8 hours since the beginning of the blackout event.

An analysis of the beyond design basis accidents for RBMK units is accomplished only for the initial period of the accident, when the fuel rod geometry is intact. An accident progression analysis at the later stages is based on expert judgment.

Results of the analysis of accidents caused by drainage of spent fuel pools and spent fuel storage facilities at RMBK reactor plants demonstrates that loss of water in the spent fuel pool caused by loss of cooling occurs rather slowly. In the spent fuel pool water heats up to the boiling point after 3 days. It takes about 15 days for water over SFAs to boil out to dry-out of a fuel cladding surface. According to the estimates made, recovery of spent fuel pool make-up at a rate of about ~10 m^3/h can ensure heat removal fully compensating for residual heat generation in SFAs.

According to the estimates made, for Bilibino-1-4 and Beloyarsk-3 a core damage and meltdown can only occur in case of extreme external events in combination with a failure of the emergency protection or due to direct mechanical damage of fuel rods (caused by falling heavy items).

For EGP-6 reactors, the accident with a long-term loss of heat removal from the core of shutdown reactor, including accidents with complete drainage of the spent fuel pool cannot cause heat-up of fuel rods to a temperature at which loss of integrity occurs, due to a small size of the core and properties of core components and reflector.

According to the results of the analysis, in case of BN-600 reactor a long-term blackout cannot lead to fuel rod heating to the limiting temperatures, since approximately after 2 days since the beginning of blackout the fuel and reactor pressure vessel temperature will start decreasing due to natural convection of large volume of sodium in the reactor vessel and in the secondary circuit.

Presently, an additional emergency core cooling system has been installed at Beloyarsk-3, which uses an air heat exchanger that is designed to remove heat from the reactor through intermediate heat exchanger at the expense of natural convection. Implementation of the system will allow maintaining proper heat removal from the reactor core for unlimited time.

Severe fuel damage in the spent fuel pool of the Beloyarsk-3 caused by loss of forced cooling is impossible, since due to a large amount of water in the spent fuel pool, the rate of water heating, even if it is loaded to the maximum, does not exceed 1°C/day, and at a water temperature of 40°C residual heat generation is fully compensated for by evaporation from the water surface.

Hydrogen safety of Beloyarsk-3 is determined by the amount of possible hydrogen generated during interaction of sodium with water due to loss of integrity of steam generator tubes. As a result of the exothermic reaction between sodium and water, the steam generator shell can be damaged and the generated hydrogen can be released into the steam generator compartment. Explosion resistance of the steam generator compartment is provided by the dislodge panels installed in the walls of the steam generator compartment.

At the units of Bilibino NPP, residual heat is removed in case of accidents with station blackout by boiling coolant. The generated steam is released through the main relief valve. After 6 hours since the beginning of the accident, residual heat generation is compensated by heat removal to the environment.

Additional safety assessment reports were submitted by Rosenergoatom to Rostechnadzor for review. The plans of NPP safety enhancement measures produced on the bases of the analysis results were included into the reports.

Main conclusions for VVER reactor plants

1. At a number of power units with VVER reactors, special engineered systems for severe accident management are implemented and operated (containment hydrogen monitoring and removal system, system for monitoring coolant level in the reactor vessel as a part of in-core monitoring system).
2. An in-depth analysis of the severe accident scenarios with fuel melting and release of radioactivity into the environment was performed with the use of modern computer codes. The main stages of accident progression, phenomenological and temporal parameters were determined.
3. Rosenergoatom has in its disposal a number of certified domestic and foreign computer codes for analysis of severe accidents at NPPs with VVER reactors.
4. A “Generic guide on severe accident management for VVER-1000 reactor plants” and severe accident management guide for Balakovo NPP have been produced.

Main conclusions for RBMK reactor plants

1. The units with RBMK reactors are equipped with engineered systems ensuring integrity of the reactor installation’s structural components and leaktight compartments during severe accidents.

2. There is a possibility to implement passive air cooling of the reactor installation for RBMK units.

3. Personnel have enough time (at least 3 days) to undertake accident management actions in case of complete drainage of the spent fuel pools in the reactor building or at the spent fuel storage facilities.

Main conclusions for NPPs with BN-600 and EGP-6 reactor plants

1. Long-term blackout accidents cannot cause fuel damage in excess of the design limits for Bilibino-1-4 and Beloyarsk-3.

2. Heat removal from the reactors can be performed in a passive manner.
3. Accidents with long term loss of reactor cooling do not cause accumulation of explosive concentrations of hydrogen in rooms and compartments of the power units.

4. Loss of forced cooling and dewatering of spent fuel pools does not result in fuel rod damage in excess of the maximum design limit.

Identified issues common for all NPP units

1. The lists of scenarios causing fuel rod damage in excess of the maximum design limit and representative from the standpoint of development of accident management measures should be refined.

2. An analysis of radiation consequences of severe accidents should be carried out.

3. Analytical and experimental research projects should be initiated on the international community level in the following areas:
   - hydrogen ignition and detonation;
   - filtered venting of the containment;
   - steam explosion.
4. An analysis of sufficiency of engineered systems, documentation and personnel for severe accident management in case of accidents affecting several units of a multiunit NPP simultaneously needs to be completed.
5. Some units are not equipped with hydrogen monitoring and removal systems. The issue of hydrogen safety at high hydrogen concentrations is yet to be resolved.
6. The existing fleet of instrumentation and controls does not ensure proper monitoring and control of the state of a reactor unit and containment nor the storage of the recorded information in the conditions of a severe accident.
7. Systems for containment sampling during and after the accident are missing.
8. Development of severe accident management guides is not complete.

Issues identified for VVER reactor plants

1. The design of the operational NPPs with VVER reactors does not provide for controllable filtered release from the containment into the atmosphere needed to maintain containment integrity during severe accidents.
2. For a number of power units (at Balakovo, Kalinin and Kola NPPs) the possibility of controllable release from the reactor was not verified.

Issues identified for RBMK reactor plants

1. The design does not provide for the possibility of controllable filtered release from leaktight rooms and compartments.
2. Severe accident analysis needs to be performed to cover the stage of loss of the fuel rod original geometry in the core, including a hydrogen explosion safety analysis.
3. The existing computer codes are not properly verified for the analysis of severe accidents at RBMK reactors.

3.2.b. Information about time schedules and measures planned

Taking into account the identified safety issues, Rosenergoatom performed an additional assessment of preparedness of the Russian NPPs to manage severe accidents. All measures on the list are categorized as short-term and mid-term actions.

Short-term measures (2012-2014):

1. Development and implementation of instrumentation and controls needed to ensure proper monitoring and control of RI during severe accidents (a number of monitored parameters needs to be increased and the measurement ranges for the major parameters need to be extended) – for all NPP units.
2. Complete implementation of the hydrogen monitoring and removal systems at the power units, where original design did not include such systems.
3. Develop a list of cases and perform an additional severe accident analysis, including an analysis of radiation consequences of severe

accidents inside the building, on-site, and off-site for justification of efficiency of severe accident management strategies.

4. Development of additional measures to equip NPPs with communication systems for the conditions of beyond design basis accidents (for communication on-site and with the crisis centers);
5. Development of additional measures to enhance protection of the locations of continuous presence of the personnel.
6. Refining the emergency documentation, inclusively to properly reflect the scenarios in which an operational event (accident) affects several units at once.

Mid-term measures (2014-2017):

1. Accomplish an analysis of sufficiency of engineered systems, documentation and personnel for severe accident management in case of accidents affecting several units of a multiunit NPP simultaneously – for all NPPs.
2. Perform level 2 probabilistic safety analysis for NPP units and an assessment, based on the analysis results, of sufficiency of engineered systems and organizational measures for beyond design basis accident management for all NPPs.
3. Analyze efficiency and feasibility of the external cooling of the reactor pressure vessel – for all VVER units.
4. Develop and implement controllable filtered venting from the containment for all VVER units (except Kola-1,2 and Novovoronezh-3,4).

5. Develop and implement the system for taking samples from the containment during and after accidents - for all VVER units.
6. Develop severe accident management guides for all units, for which such guides do not exist.

3.2.c. Preliminary results of the Operator's activities

As of today, Rosenergoatom has already performed a number of actions to ensure preparedness of the Russian NPP to manage severe accidents. These actions include the following:

- analysis of in-pile stage of severe accidents for "high pressure" scenarios (long-term station blackout) and "low pressure" scenarios" (combination of primary LOCA and long-term station blackout) was performed for majority of the VVER units;
- hydrogen monitoring and removal systems have been implemented at seven VVER units; at other units the implementation of such systems is in progress according to the approved schedule;
- severe accident management guides were developed for Balakovo NPP.

The measures planned by Rosenergoatom in order to enhance preparedness of power units for severe accident management will allow achieving the following:

- draw conclusions about adequacy of the severe accident management measures and strategies;
- decrease the probability of development of design basis accidents into beyond design basis accidents, and of beyond design basis accidents into severe accidents;

– minimize radiation consequences of severe beyond design basis accidents.

The implementation of the intended measures will ensure preparedness of NPP units for severe accident management.

3.3. Actions taken by the Regulator

3.3.a. Brief discussion

After the accident at Fukushima Daiichi NPP, Rostechnadzor conducted a series of inspections to assess, among other things, the issues of preparedness of the Russian NPPs to manage severe accidents.

Rostechnadzor determined the scope and content of additional NPP safety assessments, including assessment of preparedness of the Russian NPP units to manage severe accidents.

The results of review of additional safety assessments of NPP units were discussed with Rosenergoatom in order to identify the most significant safety issues and revise the list of actions aimed at enhancing preparedness for severe accident management.

3.3.b. Time schedules and milestones of measures planned by the Regulator

The main areas of activities of Rostechnadzor intended to enhance preparedness of NPP power units for severe accident management are formulated as follows:

– revision of a number of federal standards and rules in terms of requirements for providing power units with engineered systems and organizational measures intended for severe accident management;

– development of a safety guide concerning emergency operating procedures;

– development of additional requirements for the beyond design basis and severe accident management guides and for review of these documents;

– control of implementation of the measures planned based on the results of the additional analysis of protectiveness of the Russian NPPs against extreme external impacts and of the measures intended to enhance preparedness to manage severe accidents.

3.3.c. Rostechnadzor conclusions

The following conclusions were made based on the results of additional safety assessments of the power units in relation to preparedness for severe accident management.

1. The measures developed by Rosenergoatom in order to enhance preparedness of NPP power units to manage severe accidents are justified and sufficient, in terms of both the implementation of additional engineered systems and the development of emergency operating procedures.
2. The need to improve the regulatory bases concerning severe accident management issues was identified.
3. The lists of severe beyond design basis accidents need to be extended.
4. The existing safety issues related to severe accident management preparedness do not require NPP operating modes to be changed.

3.4. Summary Table

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(3.2.a) Accomplished? In progress? Planned?	(3.2.b) Schedule or major milestones of the planned activities	(3.2.c) Results available: Yes? No?	(3.3.a) Accomplished? In progress? Planned?	(3.3.b) Schedule or major milestones of the planned activities	(3.3.c) Conclusions available: Yes? No
Additional assessment of NPP preparedness for severe accident management	Accomplished	Accomplished in 2011	Yes	Review completed	Accomplished in 2011	Yes
Development and implementation of emergency I&C for monitoring and control of RIs during severe accidents	In progress	2014	Yes			
Development and implementation of measures to enable controllable release from the reactor (for VVER units) and from LCs (for RBMK units)	In progress	2014	Yes			
Implementation of the system for monitoring hydrogen concentration and emergency hydrogen removal for VVER and RBMK units	In progress	2014	Yes			
Development of the list of cases and performing additional analysis of severe accidents	In progress	2014	Yes			

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(3.2.a) Accomplished? In progress? Planned?	(3.2.b) Schedule or major milestones of the planned activities	(3.2.c) Results available: Yes? No?	(3.3.a) Accomplished? In progress? Planned?	(3.3.b) Schedule or major milestones of the planned activities	(3.3.c) Conclusions available: Yes? No
Performing level 2 PSA and assessment of adequacy of the existing BDBA management measures based on the results of analysis	Planned	2017	Yes			
Analyze efficiency and feasibility of the external cooling of VVER RPV	Planned	2017	No			
Develop and implement the system for taking samples from the VVER containment during and after accidents	Planned	2017	No			
Development of severe accident management guides for all NPP units	In progress	2017	No			
Control of implementation of the measures developed by Rosenergoatom based on results of the additional NPP safety analysis				In progress	Until 2017	Yes
Amendment of the federal nuclear standards and rules				Planned	2015	Yes
Adoption the PSA Policy Statement				Completed	Completed in 2012	Yes

4. Topic 4. National Organizations

4.1. Brief discussion of the topic

The present section provides brief information about the powers of the President of the Russian Federation, the Government of the Russian Federation, governmental bodies and organizations involved in ensuring safety of NPs, making decisions in case of operational events at NPP, and taking part in accident consequences elimination activities at NPPs.

The President of the Russian Federation:

– determines the main lines of the state policy in the area of the use of atomic energy;

– makes decisions on the safety issues of the use of atomic energy;

– makes decisions on the issues of prevention of emergency situations and mitigation of their consequences at the use of atomic energy.

The Government of the Russian Federation:

– issues orders and decrees related to the use of atomic energy based on and in furtherance of the Constitution of the Russian Federation, federal laws, and edicts of the President of the Russian Federation;

– organizes development of the federal target programs in the area of the use of atomic energy, approves them and provides for their implementation;

– defines the functions, activities, rights and responsibilities of the administrative and regulatory authorities in the area of the use of atomic energy according to the legislation of the Russian Federation;

– adopts resolutions on development and construction of the state-owned nuclear facilities, radiation sources and storage facilities.

In 2011, the Government of the Russian Federation adopted the federal target program “Mitigation of the Consequences of Radiation Accidents until 2015” and made amendments to the federal target program “Decrease of Risks and Mitigation of Consequences of Emergencies of Natural and Man-Induced Origin in the Russian Federation until 2015”. The changes are related to improvement of the system for monitoring and forecasting the situation on the radiation contaminated territories and development of technologies for preparing information required to organize operative interaction of the monitoring system with the automated system of the national crisis management center.

The State Atomic Energy Corporation ROSATOM performs the function of the state control of the use of atomic energy, inclusive at the Russian NPPs. According to a decree of the Government of the Russian Federation, ROSATOM is a competent authority and a point of liaison for performing the obligations of the Russian Federations ensuing from the 1986 Convention on the Early Notification of Nuclear Accidents and from the 1987 Convention on Assistance in Case of Nuclear Accident or Radiological Emergency. The Law “On the Use of Atomic Energy” delegates the functions related to mitigation of accidents associated with the use of atomic energy to ROSATOM.

The Operator of the Russian nuclear power plants is the Open Joint Stock Company “Russian Concern for Heat and Electricity Generation at Nuclear Power Plants” (Rosenergoatom).

Nuclear power plants of Rosenergoatom are its affiliates. NPPs are operated on the basis of operating licenses issued by Rostechnadzor.

According to the requirements of the Convention on Nuclear Safety and provisions of the Federal Law "On the Use of Atomic Energy", Rosenergoatom as an operating organization bears full responsibility for safety of all operating NPPs in Russia. As of the beginning of 2012, the total staff of Rosenergoatom amounted to 34,475 employees.

A list of the national organizations providing technical and scientific support to Rosenergoatom on the issues related to NPP safety, including emergency response and accident consequences elimination is provided in Appendix 5.

The Federal Hydrometeorology and Environmental Monitoring Service (Rosgydromet) monitors the radiation situation in the territory of the Russian Federation in the framework of the state radiometry service (independently of the operators). Its functions include the following:

- state monitoring of atmospheric air and surface water bodies;
- informing about the conditions of the environment, environmental pollution, and (in urgent manner) about hazardous natural phenomena, on actual and predicted sudden changes of weather and environmental pollution that can jeopardize the life and health of public or harm the environment.

The Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters (EMERCOM) is a continuously acting management body of the Unified State System for Prevention and Elimination of Emergencies (RSPEE). EMERCOM also organizes interaction and coordination of activities of all ministries, agencies and organizations during elimination of accident consequences at nuclear plants beyond the boundaries of controlled areas of the affected sites.

EMERCOM organizes training and engagement of emergency rescue teams for prompt confinement and elimination of consequences of emergencies. EMERCOM performs the functions of the state regulation of fire safety at the use of atomic energy.

The Federal Environmental, Industrial and Nuclear Supervision Service (Rostechnadzor) acts in the Russian Federation in accordance with the requirements of the Convention on Nuclear Safety. Rostechnadzor performs the functions of the state nuclear safety regulatory authority, including statutory nuclear safety regulation, federal supervision and monitoring in the area of the use of atomic energy, and licensing in the area of the use of atomic energy. Rostechnadzor organizes and implements control of nuclear facilities, inclusive during accidents. As of the beginning of 2012, a total number of Rostechnadzor employees (central office and interregional offices for supervision of nuclear and radiation safety) involved in safety regulation was about 1,060. Rostechnadzor has two scientific and technical support organizations for nuclear and radiation safety issues with the total stuff of about 400 individuals.

The Federal Medical and Biological Agency (FMBA) is the state safety regulatory authority performing state sanitary and epidemiological supervision of the use of atomic energy.

The Federal Service for Protection of Customer Rights and Public Wellbeing (Rospotrebnadzor) performs regulation and supervision in the area of ensuring sanitary and epidemiological wellbeing of the public, including radiation safety of the public. The Service performs the following functions:

– monitoring of compliance with requirements of the Russian Federation legislation related to sanitary and epidemiological wellbeing of the public;

- accounting and control of individual radiation exposure doses (in the framework of unified state system of accounting and control of individual radiation exposure doses);
- recording of the individuals affected by radiation impact;
- social and hygienic monitoring of radiation parameters;
- sanitary controls at the border checkpoints of entry to the Russian Federation;
- investigation into radiological accidents.

4.2. Actions taken by the Operator

4.2.a. Overview of the actions taken or planned by the Operator

In March–April 2011, Rosenergoatom accomplished audits of the operating NPPs, including the review of effectiveness of plant departments and of the technical support organizations and organizations rendering services to Rosenergoatom in case of accidents at NPP. During additional analysis of NPP protectiveness against extreme external impacts, preparedness of the organizations for emergency response was also assessed.

A comprehensive emergency exercise was performed at Novovoronezh NPP in 2011, over 100 individuals took part in the exercise on the site and in the external locations. The NPPA group of Rosenergoatom, ROSATOM Crisis Center, Technical Support Centers of the organizations supporting plants in emergency, NPP contractors, Rostechnadzor representatives, local authorities, EMERCOM, FMBA representatives and representatives of other organizations participated in the activity. Interaction between various organizations involved in the emergency response activities was practiced during the exercise.

In 2011, Rosenergoatom conducted seven joint emergency drills with participation of Rosenergoatom experts and technical support centers.

Main conclusion

The state system ensuring proper interaction of various governmental agencies and national organizations related to the uses of atomic energy is established and functions efficiently in the Russian Federation, in accordance with the current legislation and the powers granted to the organizations by the Government of the Russian Federation.

4.2.b. Information of time schedules and measures planned

Routine activities intended to maintain NPP safety performance at the appropriate level are performed as planned and will be continued in the future, including interaction with national organizations in part of emergency response.

In 2008, an interdepartmental working group produced a draft of "Provisions for Organization of Interaction of the Federal Authorities, Authorized Body for Control of the Use of Atomic Energy, Executive Bodies of the Russian Federal Subjects, Local Authorities and the Operating Organization in Case of a Radiation Accident at a Nuclear Plant". In 2009, the document was tested during a comprehensive emergency exercise conducted at Balakovo NPP and approved by the Governmental Commission for Prevention and Elimination of Emergencies and Fire Safety. The Provisions are presently undergoing the official approval process.

4.2.c. Preliminary or final results of the Operator's activities, including proposed future actions

The activities of Rosenergoatom related to interaction with the national organizations on the issues of emergency response is effective, well-structured, and ensures clear division of functions and responsibilities of the national organizations.

4.3. Actions taken by the Regulator

4.3.a. Overview of the actions taken or planned by the Regulator

In 2011, Rostechnadzor conducted operative inspections to assess degree of protection of the Russian NPPs against external man-induced and natural impacts and preparedness for managing beyond design basis accidents, including severe accidents.

Rostechnadzor reviewed the analysis of protectiveness of the Russian NPPs against extreme external impact, produced by Rosenergoatom. The results of the review were discussed with Rosenergoatom and presented at the joint meeting that took place in Rostechnadzor in December 2011.

Rostechnadzor participated in development of the plan of measures to enhance NPP safety produced by ROSATOM in 2011 and controlled implementation of the plan.

Rostechnadzor took part in the comprehensive emergency exercise conducted in 2011 at Novovoronezh NPP to practice emergency preparedness aspects. Representatives of Rostechnadzor participated in 7 emergency response exercises conducted by Rosenergoatom jointly with the technical support organizations.

In 2011, pursuant to the IAEA recommendation, Rostechnadzor signed an agreement with FMBA on coordination of safety regulation activities.

Main conclusion

Effective and competent safety regulatory authorities are in place and function in the Russian Federation, regulating nuclear and radiation safety of NPPs jointly with other national organizations.

4.3.b. Information on time schedules and measures planned

Rostechnadzor performs and will continue supervision of organizations involved in the use of atomic energy. Rostechnadzor has planned to conduct an in-depth analysis of effectiveness of the regulator’s activities in case of emergencies at NPPs. The analysis is to be focused on the operation of the information and analytical center of Rostechnadzor. Based on results of the analysis, which is scheduled to accomplish in 2012, necessary organizational and engineered measures will be taken to improve effectiveness of the information and analytical center of Rostechnadzor during emergency response.

4.3.c. Preliminary or final results of the Regulator’s actions, including proposed future actions

The Russian regulatory authorities possess the necessary effectiveness and competence in emergency response issues, and are capable of performing their safety regulatory functions.

4.4. Summary table

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(4.2.a) Accomplished? In progress? Planned?	(4.2.b) Schedule or major milestones of the planned activities	(4.2.c) Results available: Yes? No?	(4.3.a) Accomplished? In progress? Planned?	(4.3.b) Schedule or major milestones of the planned activities	(4.3.c) Conclusions available : Yes? No?
Analysis of effectiveness of the national and industry	Completed	2011	Yes	Completed	2011	Yes

Activities	Activities performed by the Operator			Activities performed by the Regulator		
	(4.2.a) Accomplished ? In progress? Planned?	(4.2.b) Schedule or major milestones of the planned activities	(4.2.c) Results available: Yes? No?	(4.3.a) Accomplished? In progress? Planned?	(4.3.b) Schedule or major milestones of the planned activities	(4.3.c) Conclusions available : Yes? No?
system for prevention and elimination of emergencies						
Comprehensive emergency exercise at Novovoronezh NPP	Completed	2011	Yes			
Analysis of effectiveness of actions of the regulator during accidents at nuclear facilities				In progress	2012	No

5. Topic 5. Emergency preparedness and response and post-accident management (off-site)

5.1. Brief discussion of the topic

5.1.1. Regulation in ensuring emergency preparedness beyond NPP sites

The issues of emergency preparedness off-site NPPs are regulated in the Russian Federation on the basis of the requirements of international conventions signed by the Russian Federation, the requirements of the federal legislation, governmental decrees, and federal standards and rules. The requirements are intended to prevent occurrence and development of emergencies and to minimize the damage incurred. They determine guidelines for protection of the citizens of the Russian Federation and foreign individuals, as well as of the environment against natural and man-induced emergencies. The Russian regulatory documents on the issues of emergency response were developed taking into account the IAEA safety standards, in particular, the standard “Arrangements for Preparedness for a Nuclear or Radiological Emergency” (GS-G-2.1, IAEA, Vienna, 2007).

The Russian Federation participates in the international agreements based on the requirements on the international conventions concerning emergency preparedness issues, including the accidents with transboundary consequences:

- Convention on Nuclear Safety, 1994;
- Convention on Environmental Impact Assessment in a Transboundary Context, 1991;
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, 1987;

– Convention on Early Notification of a Nuclear Accident, 1986.

5.1.2. Structure of the unified Russian state system for prevention and elimination of emergencies

According to the Federal Law “On Protection of Public and Territories in Case of Natural and Man-Induced Emergencies", a unified state system for prevention and elimination of emergencies situations has been established and is functioning in the Russian Federation. The Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters (EMERCOM) is a continuously acting management body of the RSPEE. RSPEE covers all regions of the Russian Federation. The daily management body of the RSPEE is the National Center for Crisis Management of EMERCOM.

Russian national system for prevention and mitigation of emergency situations consists of functional and territorial subsystems and acts on the federal, interregional, regional, municipal and site levels. Functional subsystems are established by the federal executive authorities.

RSPEE consists of functional and regional subsystems and acts on the federal, interregional, regional, municipal and site levels. Functional subsystems are established by the federal executive authorities, territorial subsystems are founded by the subjects of the Russian Federation.

The following entities are established within each subsystem:

– coordinating bodies

– management bodies;

– daily management bodies;

– force and capabilities;

– financial and material reserves;

– communication, notification and information support systems.

Fig. 5.1 illustrates the structure of radiological emergency response system management of the Russian Federation.

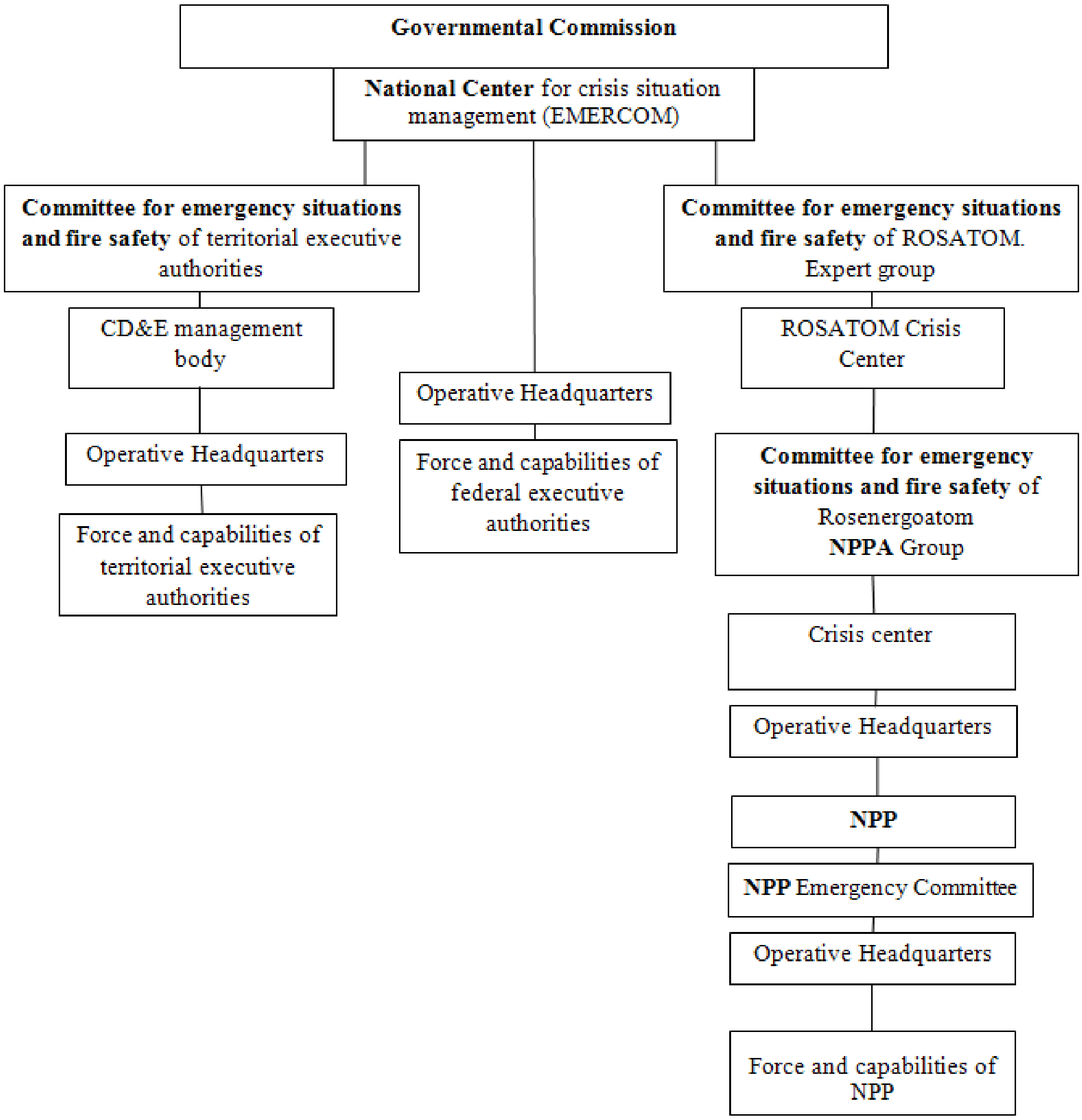

Fig. 5.1. General administrative structure of emergency response in case of radiological accidents in the Russian Federation

Within the boundaries of appropriate emergency zones, commissions for prevention and elimination of emergencies and fire safety were established depending on features of potential emergencies, and individuals responsible for coordination of the emergency elimination activities were appointed. The emergencies are eliminated with the use of all force and capabilities available in the affected zone.

EMERCOM organizes interaction and coordination of activities of all ministries, agencies and organizations during accident response at NPPs and accident management activities beyond the boundaries of the plant site. EMERCOM organizes training and the use of emergency rescue teams for prompt confinement and elimination of consequences of emergencies.

In case of an accident on a foreign NPP involving a radiation impact on the territory and the public of the Russian Federation, or in case where an accident on a Russian NPP can result in a radiation impact on the territories of neighboring countries, the international interaction is in place in accordance with the requirements of the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and Convention on Early Notification of a Nuclear Accident. ROSATOM is an authorized authority and point of contact regarding obligations of the Russian Federation under the aforementioned conventions.

5.1.3. Industry-wide system for prevention and elimination of emergencies. Rosenergoatom system for prevention and elimination of emergencies

The industry-wide system for prevention and elimination of emergencies (IEPES) at NPPs and other nuclear facilities has been created and is functioning in ROSATOM. Fig. 5.2 illustrates the structure of the system.

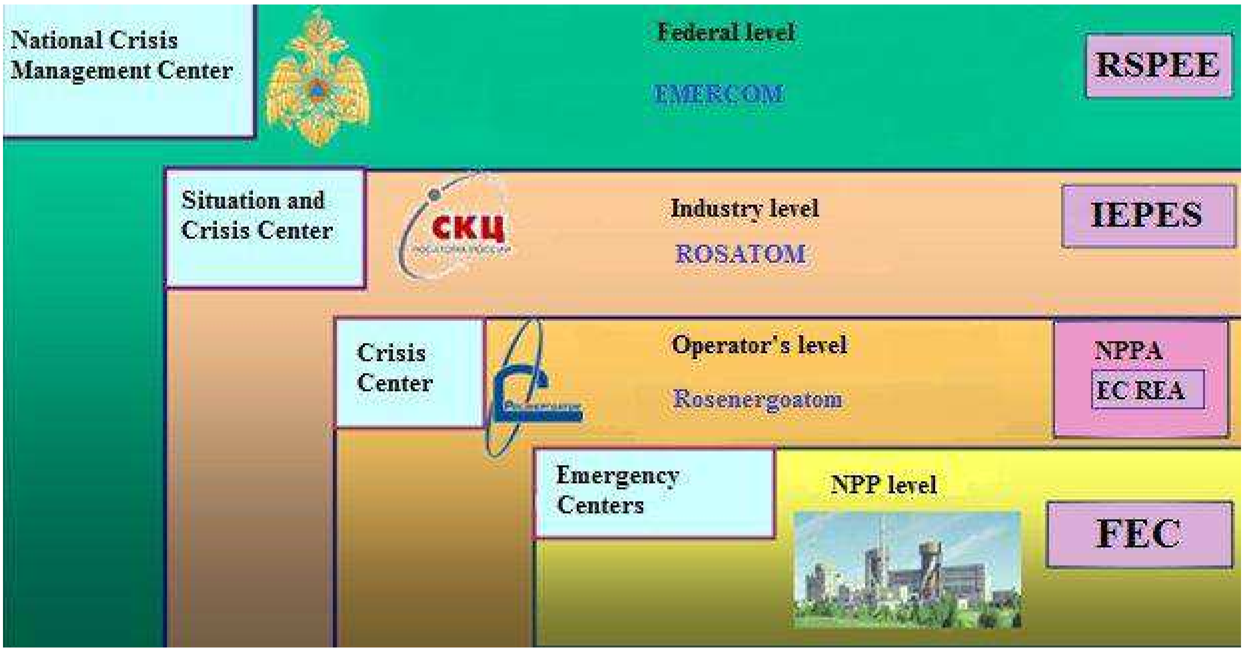

Fig. 5.2. The industry-wide system for prevention and elimination of emergencies

In the Rosenergoatom central office and at every NPP, preferred and stand-by systems for communication with ROSATOM, state safety regulatory authorities and other federal executive authorities, local and municipal civil defense organizations and EMERCOM departments, executive bodies of the Russian Federal Subjects and local authorities have been created.

The system of communication of the organizations involved in the emergency response system is shown on the Fig. 5.3.

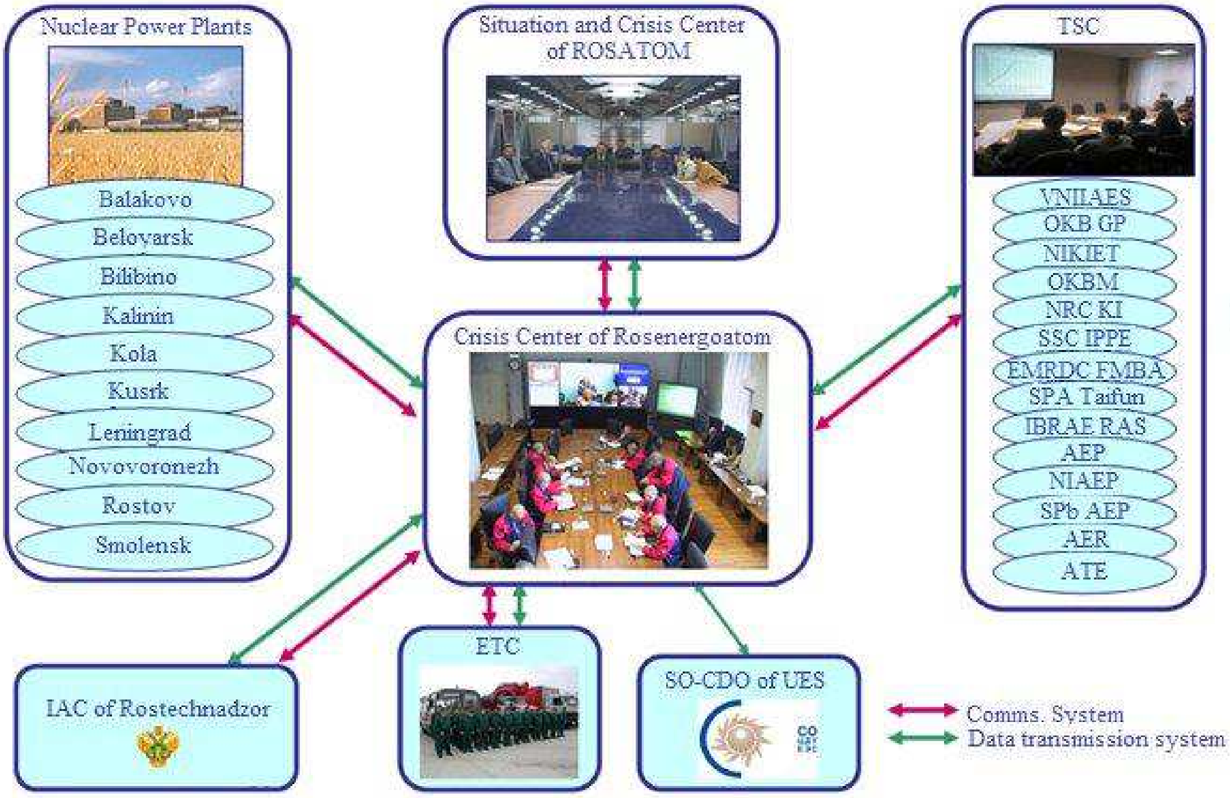

Fig. 5.3. Operative communication of the organizations involved in the emergency response system of ROSATOM and Rosenergoatom

Key components of the emergency response and support of NPPs in case of accident are as follows: Rosenergoatom Crisis Center, ROSATOM Crisis and Situation Center, Rostechnadzor Information and Analytical Center, and technical support centers in the organizations performing the functions of the Chief Designer, Scientific Supervisor and Architect General, or leading Russian institutes and enterprises providing scientific and technical support to NPPs. The existing communication and notification systems ensure timely notification and exchange of the necessary information with all relevant organizations in case of an emergency at a NPP.

Fig. 5.4 illustrates the structural diagram of the Rostechnadzor subsystem of control of nuclear and radiation hazardous facilities and interaction with Rosenergoatom Crisis Center in the framework of the national emergency response system.

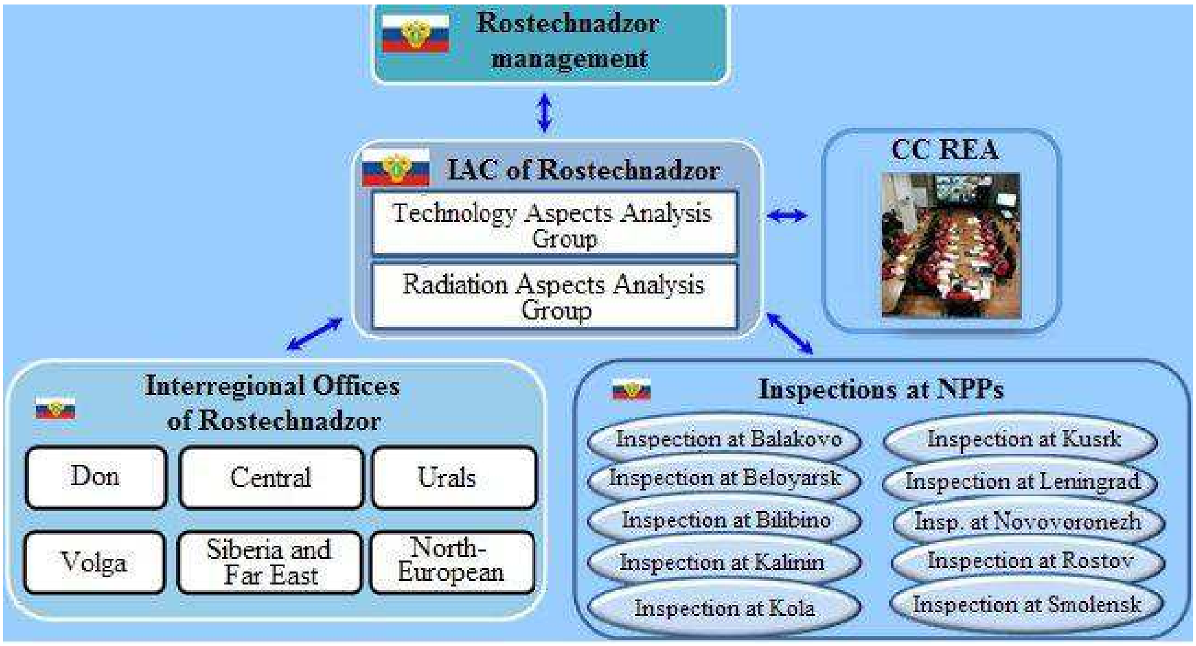

Fig. 5.4. Structural diagram of Rostechnadzor subsystem of control of nuclear and radiation hazardous facilities and interaction with the Rosenergoatom crisis center in the framework of the national emergency response system

The measures to ensure emergency preparedness of the Russian NPPs and to implement “Action Plan of the Personnel Protection in Case of an Accident at a Nuclear Plant" are prescribed by the document “Provisions for Declaring Emergency, Operative Transfer of Information and Organizing Assistance to Nuclear Plants in Case of Radiation Hazardous Situations". The “Provisions…” establishes the criteria for declaring the state of “Alert” and “Emergency” at NPPs.

5.1.4. Plans for personnel and public protection

The following documents have been produced and approved on the basis of the regulatory legal instruments:

- at NPPs – “Plans of Measures to Protect the Personnel in Case of an Accident at the Nuclear Plant”;
- in the Russian Federal Subjects and local authorities which host NPPs - “Action Plans to Protect the Public in Case of an Accidents at the NPP”;

The aforementioned plans contain division and delineation of responsibilities of Rosenergoatom, NPP, and local authorities, define coordination and interaction of the nuclear plants with territorial departments of EMERCOM and other ministries and agencies involved in the implementation of measures intended to protect the public against consequences of an accident.

According to the “Action Plans to Protect the Public in Case of an Accidents at the NPP”, the head of the local administration and the head of the Russian Federal Subject are responsible for ensuring protection of public. The “Plans of Measures to Protect the Personnel in Case of an Accident at the Nuclear Plant” have been developed and authorized by the executive authorities of appropriate territories of the Russian Federal Subjects.

The plans of measures to protect the public in case of accidents at NPPs are developed by the executive authorities of appropriate Russian Federal Subjects with involvement of NPPs.

5.1.5. Crisis management during accidents at NPPs. Organization of management during elimination of consequences of radiation accidents at NPPs

The management of elimination of radiation accident consequences at NPPs depends on their scale and is carried out at one of three levels: on-site, regional or federal.

In case of an accident at the plant, irrespectively of its scale the management of Rosenergoatom, ROSATOM, local authorities, EMERCOM, Rostechnadzor and other organizations are immediately notified thereof as per the adopted notification schedule.

5.1.6. Accident with radiation consequences within the NPP controlled area

If only the NPP site and controlled area have been affected by radioactive contamination resulted from the accident, the elimination of its consequences is carried out by force and capabilities of the NPP.

The emergency operations commander (NPP director) commands force and capabilities engaged in elimination of emergencies and arranges for interaction thereof.

When necessary, the direct coordination of actions of force and capabilities during a radiation accident at the NPP can be provided by the group for emergency assistance to nuclear plants (NPPA) established in Rosenergoatom. The NPPA is headed by the Director General of Rosenergoatom. The composition, functions and tasks of the NPPA group, procedures for fitting it with required means of transport, means of communication and other gear are determined in the federal standards and rules.

To ensure management in case of a radiation accident at the NPP, protected emergency response control posts at NPP (PERCP NPP), in the plant’s satellite city (PERCP SC), and in the evacuation area (PERCP EA) have been set up. The PERCP SC and PERCP EA include work stations and necessary means of communications for operations teams of administrations of satellite cities and rural regions.

All NPPs have direct communications channels linked to on-duty dispatcher units of local CD&E authorities.

5.1.7. Accident with radiation consequences beyond the controlled area boundaries

Measures to protect the public and eliminate accident consequences (management of emergency response actions) beyond the controlled area boundaries within a municipality or a Russian Federal Subject are carried out by force and capabilities of the regional executive bodies (regional subsystem of RSPEE).

The operational evaluation and forecasting of the radiation situation beyond the CA boundaries are done by the NPP. Results of the evaluation and recommendations are forwarded to the regional executive authorities for necessary decision-making.

When necessary, force and capabilities of the federal executive bodies (functional subsystems of RSPEE) can be engaged in the elimination of the accident consequences; in this case they are put under operative command of commanders of operations to eliminate the radiation accident and its consequences.

5.1.8. Accident with radiation consequences affecting territories of several Russian Federal Subjects

In case of radioactive contamination of territories of several Russian Federal Subjects the management (coordination) of works to eliminate the accident and its consequences are undertaken by the Governmental Commission for Prevention and Elimination of Emergencies and Fire Safety. In separate cases of radiation accidents at NPPs a special Governmental Commission can be assigned. It commands the elimination of the accident and its consequences using force and capabilities of RSPEE.

The organization of the elimination of the accident and its consequences is based on action plans of prevention and elimination of emergencies generated in advance at all tiers of RSPEE; these plans contain actions to eliminate radiation accident consequences. These plans are generated basing of a risk assessment of emergencies for a corresponding territory, including radiation ones, and on potential work solutions.

Response actions of controls, force and capabilities of RSPEE to a radiation accident are normally divided into two stages.

Stage One (organization and conduct of reconnaissance) covers the period of time elapsed since the receipt of information on the radiation accident occurrence until the point of time where its actual scale is determined and measures to protect the public are taken. Stage Two is actions to eliminate the radiation accident.

The backbone of force and capabilities of RSPEE engaged in elimination of radiation accidents' consequences are units of regional subsystems of the Russian Federation which territories have been affected by the radiation accident.

5.1.9. Force and capabilities engaged in elimination of radiation consequences beyond NPP site

The regional force and capabilities which can be engaged in emergency rescue and other urgent operations beyond the CA boundaries in case of accidents at NPPs include:

- force and capabilities of the Russian Federal Subjects and municipalities;
- force and capabilities of law enforcement and road police of the Ministry of Interior of Russia, and that of the Russian Federal Subjects and municipalities;
- professional emergency rescue units of ROSATOM and other agencies and the Russian Federal Subjects;
- regional and municipal emergency rescue units and voluntary rescuers.

According to the agencies interaction plans, professional (paramilitary) emergency rescue units of other agencies, which base in the territory of the affected or neighboring Russian Federal Subjects, may be engaged in the elimination of radiation accident consequences.

The engagement of the force and capabilities of the functional subsystems of RSPEE, Ministry of Defense of Russia and Ministry of Interior of Russia, as well as civil defense units are engaged in accordance with the procedure laid down by the existing legislation.

5.1.10. Public information on emergency preparedness

The Information and Public Relations Department of Rosenergoatom carries out public information activities. In case of emergencies at NPPs the Department:

- arranges for collection of information on initiation and development of the accident at the NPP, measures being taken to confine it and to eliminate its consequences;
- prepares and have approved by the NPPA group management the press releases for mass media; ensures fastest release of information to mass media;
- organizes press conferences of the NPPA group management;
- monitors electronic and print mass media as to issues relating to the situation at the NPP;
- arranges for posting information about the accidents and measures being taken to confine it and eliminate its consequences on Rosenergoatom's website;
- interacts with information departments of NPPs.

For the public information, information departments, which are charged with the tasks similar to the above, operate at all NPPs.

5.1.11. Training and emergency drills at NPPs

The following is conducted to train the plant personnel in emergency actions: training in technical support centers, emergency drills, paper and target tactics exercises, reserve training.

The employees of Rosenergoatom, NPP personnel, employees of the civil defense, emergency prevention and elimination support enterprises are trained in accordance with the requirements of the resolution of the Government of the Russian Federation "On Training of the Public in

Protection against Emergencies of Natural and Man-Induced Origin" and "Provisions for Organization of Civil Defense Training of the Public."

Special departmental units of NPPs are trained in accordance with the "Provisions on a Special Departmental Unit of NPP".

The following is conducted at Rosenergoatom:

- learning training for CD&E officials and employees of the central administration and NPPs; at least, once a year;
- comprehensive emergency exercises with involvement of the NPPA group, emergency technical centers, force and capabilities of concerned federal state governmental authorities; during these the entire array of issues relating to interaction and response of the exercise participants to radiation accidents, implementation of the public protection measures, including with engagement of the civil defense force and capabilities, are practiced; once a year;
- emergency drills with the participation of NPPA group;
- operative tactical counter terrorist exercises during which the interaction of the NPPA group, crisis center, Rosenergoatom units, technical support centers with special-purpose units of law enforcement and medical service is practiced; once a year.

The following is conducted at NPPs:

- learning training for CD&E and RSPEE managers, officials and specialists; at least, once a year;

- paper exercises to master interaction of command officials; during these, the tasks include organization of actions to eliminate accident consequences and operations in emergency conditions; once a year;
- emergency and fire drills, drills in actions of the personnel in emergency; in accordance with a schedule produced at NPPs on an annual basis.

In addition, according to a schedule produced by Rosenergoatom on an annual basis, NPPA groups, CC and TSC participate in paper exercises or plant-wide emergency drills to master interaction at least once in two years.

Drills and exercises employ simulators, including full-scale simulators of NPP units.

5.2. Actions taken by the Operator

5.2.a. Overview of the Operator's actions taken or planned

After the accident at the Fukushima-Daiichi NPP, a decision was made by Rosenergoatom to increase from one to two the number of annual emergency drills in the personnel actions in conditions of beyond design basis accidents. In April 2011, all NPPs of Rosenergoatom conducted off-scheduled emergency drills for cases involving the NPP blackout and loss of the ultimate heat sink.

In 2011, the Novovoronezh NPP conducted a comprehensive emergency exercise involving the force and capabilities of both on-site and within the CA and outside it (the parties involved included Rosenergoatom's NPPA group, the Situation and Crisis Center of ROSATOM, TSC of the organizations providing support to the NPPs, the Regulator, local authorities, forces and capabilities of EMERCOM and other agencies).

Arrangements for cooling water supply into the steam generators of Unit 5 from an open circulating water channel by a mobile pumping station and recovery of power supply to safety systems from a mobile diesel generator were the issues addressed during the emergency exercise. Also, issues concerning protective arrangements, including sheltering and evacuation of Novovoronezh City residents were practiced.

Seven joint emergency drills were conducted also in 2011, involving experts of Rosenergoatom and technical support centers.

The NPP safety upgrading measures planned by Rosenergoatom after analyzing the accident at Fukushima-Daiichi NPP include those seeking to improve the efficiency, including also the accident management efficiency:

– implementation of a set of measures to improve the reliability of communications in conditions of beyond design basis accidents, specifically introduction of an integrated radio communication system at the NPPs;
– establishment of mobile standby ground satellite communication stations;
– retrofit/establishment of mobile control centers for the persons in charge of the emergency response and for the NPPA group leader.

5.2.b Information on time schedules and measures planned

Rosenergoatom has planned the following measures seeking to improve the accident management efficiency:

– implementation of a set of measures to improve the reliability of communications in conditions of beyond design basis accidents, specifically introduction of an integrated radio communication system at the NPP;

– establishment of mobile standby ground satellite communication stations;

– retrofit/establishment of mobile control centers for the persons in charge of the emergency response and the NPPA group leader.

The measures are expected to be taken in 2014.

5.2.c Preliminary or final results of the Operator's activities, including proposals for further activities

The Russian Federation has a structured emergency response system, including to accidents at nuclear facilities, nuclear power plants included. At a national level, the RSPEE activities are coordinated by the EMERCOM. An industry-wide emergency prevention and elimination system has been established and is operated at ROSATOM, which is a structural part of the national system. Rosenergoatom and nuclear power plants include emergency management divisions. ROSATOM and Rosenergoatom have SCC and CC, respectively. Rosenergoatom includes a nuclear plant emergency assistance team, which operations involve experts from the nuclear industry's leading organizations, the EMERCOM, the Ministry of Interior, the Ministry of Defense and Russia's government authorities.

Based on an insight into the experience of the Fukushima-Daiichi accident, measures are planned to further improve the nuclear industry emergency response system.

5.3. Actions taken by the Regulator
5.3.a Brief discussion

In 2011 Rostechnadzor took part in 7 emergency drills jointly with Rosenergoatom and technical support centers.

Rostechnadzor staff was a part of the NPPA group in the 2011 comprehensive emergency exercises held at Novovoronezh NPP and supervised the activities by Rosenergoatom and involved organizations as far as the emergency response was concerned.

After the accident at Fukushima-Daiichi NPP, a study was conducted by experts of FMBA of Russia to identify the radiation factors that required limiting the vital activities of the Russian citizens and the personnel of the CIS embassies in Japan. Radiation monitoring was introduced for the air passengers arriving in Russia from Japan.

Since the Fukushima accident day, Rospotrebnadzor (the Federal Service for the Supervision in the Sphere of Consumer Rights and Human Welfare Protection) has been carrying out daily radiation monitoring of the situation in the Russian Federation’s Far East territories. The environment (including soil, water, air, snow, sea food, migrating birds and so on) has been surveyed, and radiological tests of foods coming from Japan have been introduced. At the present time, radiation monitoring is carried out for:

– conveyances, cargoes and foods coming from Japan;
– fish and sea food caught in the Pacific Ocean and in inland water bodies in the Russian Far East;
– consumed meat of birds wintering in Japan and nesting in the Russian Far East.

Main conclusion

The Russian agencies, which are responsible for the government regulation of safety in the uses of atomic energy, possess the required efficiency and competence as far as emergency response to NPP accidents and NPP safety regulation is concerned, including in emergency response.

5.3.b Information on time schedules and measures planned

On a routine basis, Rostechnadzor will continue its permanent activities in the supervision of Rosenergoatom regarding its emergency preparedness.

Rostechnadzor plans to raise the efficiency of its information and analysis center to make it more efficient in terms of emergency response.

5.3.c Preliminary or final results of the Regulator's activities, including proposals for further activities

The Russian regulatory authorities possess the required efficiency and competence as far as emergency response to accidents at nuclear plants is concerned, and have capabilities to perform, as required, their respective functions in regulation of safety, including off the NPP site.

5.4. Summary table

Activity	Activities performed by the Operator			Activities performed by the Regulator		
	(p. 2 a) Completed? Ongoing? Planned?	(p. 2 b) Schedule or milestones for planned activities	(п. 2 c) Results available Yes? No?	(p. 3 a) Completed? Ongoing? Planned?	(p. 3 b) Schedule or milestones for planned activities	(p. 3 c) Results available Yes? No?
Analysis of the efficiency of the national and industry-wide accident prevention and elimination systems (RSPEE and IEPES, respectively)	Completed	Completed in 2011	Yes	Completed	Completed in 2011	Yes

Activity	Activities performed by the Operator			Activities performed by the Regulator		
	(p. 2 a) Completed? Ongoing? Planned?	(p. 2 b) Schedule or milestones for planned activities	(п. 2 c) Results available Yes? No?	(p. 3 a) Completed? Ongoing? Planned?	(p. 3 b) Schedule or milestones for planned activities	(p. 3 c) Results available Yes? No?
Comprehensive emergency response exercise at Novovoronezh NPP	Completed	Exercise finished in 2011	Yes			
Joint emergency drills of Rosenergoatom and the nuclear industry's technical support centers	Completed	Seven drills conducted in 2011	Yes			
Analysis of the Regulator's efficiency during emergencies at nuclear facilities				Ongoing	Expected to be completed in 2012	Yes
Improvement of systems for monitoring and prediction of the situation in radioactive contaminated territories				Ongoing (as part of the FTP approved by the Russian Federation Government Resolution No. 253 dated 29 June 2011)	Expected to be completed in 2015	Yes
Creation of the technology to prepare information for the online interactions of the surveillance system and the automated system of the national crisis management system.				Ongoing (as part of the FTP approved by the Russian Federation Government Resolution No. 68 dated 31 January 2012)	Expected to be completed in 2015	Yes

6. Topic 6. International cooperation

6.1. Brief discussion of the topic

A part and parcel of nuclear and radiation safety activities is the international cooperation carried out both by Rosenergoatom and Rostechnadzor. The volume of international cooperation on nuclear safety has increased greatly since the time of the Fukushima-Daiichi accident, which was due to both the need for an exchange of information on the lessons learned and the steps taken or planned at the national level, and to the necessity for balanced and concerted measures to be taken in the framework of international organizations and associations.

Participation of the Russian Federation in international safety conventions. Proposals of the Russian Federation on amendments to the Convention on Nuclear Safety

The Russian Federation is a Contracting Party to the following conventions, the depository for which is the Director General of the IAEA:

- the Convention on Nuclear Safety signed by the Russian Federation in 1994 and adopted in 1996;
- the Convention on Early Notification of a Nuclear Accident signed and adopted by the Russian Federation in 1986;
- the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency signed and adopted by the Russian Federation in 1986;
- the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management signed by the Russian Federation in 1999 and ratified in 2006.

The Russian Federation fulfills its obligations arising out of these Conventions, submits national reports and takes part, on a regular basis, in the meetings of the Contracting Parties.

Despite the fact that the safety conventions, and primarily the Convention on Nuclear Safety (the Convention), have formed the international legal regime for ensuring nuclear safety, the Fukushima-Daiichi accident analysis results have revealed the areas, where this regime should be improved.

The Russian Federation prepared and delivered, during an IAEA Ministerial Conference on Nuclear Safety (20-24 June 2011, Vienna), to the IAEA Director General, the depositary for the Convention, its proposals on amendments to the Convention on Nuclear Safety, as well as to the Convention on Early Notification of a Nuclear Accident.

The proposals of the Russian Federation on amendments to the Convention on Nuclear Safety, as specified in Article 32, par. 1 of the Convention, are set forth in Appendix 6.

The Russian Federation believes the proposed amendments to contribute to an improvement of the international legal instruments for nuclear safety.

A mechanism of communication with neighboring countries and international community

After the Fukushima-Daiichi accident, ROSATOM, which is a competent authority for the fulfillment of the Russian Federation’s obligations arising out of the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, was exchanging information with foreign partners, primarily with the IAEA’s Incident and Emergency Center.

Following the openness and transparency principles, the Russian Federation is conducting an active dialog with the neighboring countries and international community as a whole on issues of ensuring safety of the Russian NPP units in operation or under construction, including the NPP units built in other countries under Russian designs. An example of such dialog is the communication on issues regarding the Baltic NPP construction project.

OECD/NEA

Based on the Russian Government resolution on Russia's joining the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD) and for the purpose of discussing Russia's application concerning its intent to join the Agency, the Agency's technical mission to Russia took place in January 2012, as part of which the information was furnished to back Russia's joining of the OECD/NEA.

Participation in international expert groups

Russian experts participate in the activities of the International Nuclear Safety Group (INSAG) on a regular basis.

The IAEA is implementing the INPRO project initiated by Russia, as part of which a methodology was developed addressing safety on a systemic basis with regard for the existing IAEA experience.

6.2. Actions taken by the Operator

6.2.a. Overview of the actions taken or planned by the Operator

The international activities of the Russian operating organization, Rosenergoatom, are aimed at building the favorable environment for ensuring the operation and evolution of the utility, and at providing information and resources to support the NPP operation safety and reliability upgrading activities based on foreign experience and technologies.

Cooperation with international organizations and associations

Cooperation with the IAEA

The cooperation with the IAEA is carried out by way of Rosenergoatom's participation in the IAEA technical conferences and workshops, in training courses as part of national, regional and interregional technical cooperation projects, as well as in safety conferences and safety missions to its NPPs (the OSART mission to the Smolensk NPP in 2011), and in the submission of design documentation (the AES-2006 Preliminary Safety Analysis Report) for the international expert reviews under the auspices of the IAEA, and by way of involvement in the development of the IAEA safety standards and in the IAEA's extrabudgetary programs and projects.

The representative of the Russian Federation, First Deputy Director General of Rosenergoatom, is a member of the International Nuclear Safety Group (INSAG) under the IAEA Director General.

Cooperation with the WANO

In 2011, there were 51 events conducted as part of the participation of Rosenergoatom, the operator of the Russian NPPs, in the WANO activities.

In April 2011, a WANO commission was set up under the chairmanship of T. Mitchell, composed of highly competent representatives of the member organizations and the industry from the WANO regions, including Rosenergoatom. The commission had the task of defining the required changes in the WANO, given the lessons learned from the accident at the Fukushima-Daiichi NPP. The five following recommendations were formulated by the commission:

1) the scope of the WANO programs should be extended;

2) the integrated global strategy of response to nuclear events should be introduced;

3) the quality, efficiency and frequency of peer reviews should be improved;

4) the WANO should become an organization which is more open to the public;

5) periodic peer reviews of each regional center and the London Office should be conducted.

Following the events at the Fukushima-Daiichi NPP and after the decision made by the respective countries to have the NPP safety additionally assessed, Rosenergoatom, jointly with the WANO's Moscow regional center (WANO-MC), convened a workshop entitled "Stress Testing at the WANO-MC Nuclear Plants" late August 2011.

The major conclusions arrived at the workshop were as follows:

– the WANO-MC operators were giving much attention to additional safety evaluation issues;

– the INSAG-developed fundamental safety principles took into account modern international requirements to safety, based on the experience of operation, and were not to be changed, while the NPP safety upgrading program launched at nuclear power plants before the events at the Fukushima-Daiichi NPP is to be continued with regard for the lessons learned from the accident.

A decision was made by the workshop members to establish an expert group to compare and review the operator reports regarding the additional analysis of the NPP protectiveness against extreme external impacts for the operators of VVER NPPs to shape their attitudes and unified approaches to highlighting problems and making the public aware of the analysis undertaken. Following the initial meeting of the expert group for the additional analysis of the NPP protectiveness against extreme external impacts at the WANO-MC NPPs in October 2011, summary information was compiled based on the analysis data for the VVER NPPs.

A decision was also made to consider if it was possible to establish an integrated regional crisis center (RCC) for the VVER NPPs based on Rosenergoatom's Crisis Center to support the decision-making in case of severe accidents. In 2011, a task group of representatives of Rosenergoatom and other operators, the WANO-MC members was formed for addressing the RCC establishment issues.

Top officials of Rosenergoatom took part in the WANO General Assembly in Shenzhen, China, on 23-25 October 2011, which focused on the future of nuclear power after the accident at the Fukushima-Daiichi NPP. First Deputy Director General of Rosenergoatom was elected the WANO President for the period of 2011-2013.

Participation in international forums

Round table discussions entitled "Stability of Modern Reactor Facilities to Natural Disasters. The Lessons of Fukushima" were held as part of the ATOMEXPO-2011 International Forum in June 2011 in Moscow. Top officials of Rosenergoatom delivered reports on the lessons learned from the accident at the Fukushima-Daiichi NPP at a number of international forums, including the Industrial Forum held as part of the IAEA General Conference in September 2011, the International Symposium on Nuclear Safety (ISONS2011) in November 2011, and the IAEA International Expert Meeting

"Safety Reactors in the Light of the Fukushima-Daiichi NPP Accident" in March 2012.

International audits

IAEA

One of the top-priority tasks for Rosenergoatom is to upgrade the operating safety of Russian NPPs. The steps to upgrade the Russian NPP safety are planned and taken subject to recommendations from the IAEA OSART missions composed of highly-skilled international experts.

Regular OSART missions to Russian NPPs (three times per year beginning in 2005) are undertaken in accordance with the provisions of the IAEA Nuclear Safety Action Plan adopted in September 2011.

Given the positive experience gained and the international importance of the OSART missions, Rosenergoatom initiated the invitation of further missions to be conducted in shorter intervals. ROSATOM gave go-ahead to the initiative and informed the IAEA Secretariat of the proposal to receive regular missions.

WANO

During the period of 9 to 22 April 2011, as part of Rosenergoatom's participation in the WANO activities, a corporate peer review (CPR) was undertaken by the WANO. Under Rosenergoatom's Plan of Corrective Actions based on the CPR Results, 32 events are scheduled for 2011–2012. Another corporate peer review at Rosenergoatom is scheduled for the first quarter of 2013.

Besides, the WANO peer reviews were held in 2011 at Balakovo, Bilibino, and Novovoronezh NPPs.

Cooperation in operating experience

Cooperation with the WANO

A decision was made in 2011 on enhancing further the efficiency of Rosenergoatom-WANO interaction for information exchange on operating experience through:

– making a common information environment on the NPP malfunctions, equipment failures and NPP performance;

– regularly furnishing all WANO members with information on the status of NPPs (technical information, measures taken, resources);

– communicating with organizations carrying out construction at the earliest possible design stage;

– the operators' taking a common stand with respect to the relations with the regulator and mass media.

Cooperation with EDF (France)

For over 17 years Rosenergoatom has been actively collaborating with Electricite de France, a French utility. This cooperation is based on annular science and technology exchange programs and includes operation, engineering, new projects, production engineering, inspection, manning and logistics.

Since the events at the Fukushima-Daiichi NPP, major joint efforts undertaken by Rosenergoatom and EDF have involved issues concerning exchange of experience in implementation of their respective post-Fukushima action plans. There were three such exchanges in 2011. The parties have noted the uniformity of the methodology used to assess the NPP protectiveness against external and internal impacts.

Cooperation with NAEC Energoatom (Ukraine)

The bilateral cooperation on nuclear safety has been under way with NAEC Energoatom (Ukraine) as part of which information is exchanged on the experience of operating Russian and Ukrainian NPPs with VVER reactors, including exchange of reports on investigations into the NPP malfunctions, participation as observers in Energoatom's mutual audits with respect to the use of symptom-oriented emergency procedures at NPPs, and interactions on creation of a common database of the NPP designs.

Cooperation with Iran and Canada in analyzing the NPP protectiveness against extreme external impacts

Rosenergoatom initiated an additional analysis of the Bushehr NPP protectiveness against extreme external impacts. Based on the analysis results, the Action List for the Bushehr NPP project was developed, in which the events at the Fukushima-Daiichi NPP were taken into account. In September 2011, Russia and Iran signed a protocol of interaction for the additional safety analysis of Bushehr-1, as part of which Russia is sharing its experience of performing the additional safety analysis in the Russian Federation.

As part of Rosenergoatom's long-term cooperation with Tianwan NPP, the latter was provided with information on the safety improvement actions taken at Russian NPPs with regard for additional analysis performed after the Fukushima accident.

6.2.b Information on time schedules and measures planned

In May 2012 Rosenergoatom will hold the 8th International Scientific and Technical Conference "Safety, Efficiency and Economics of Nuclear Power Industry" (MNTK-2012).

In June 2012 Rosenergoatom, jointly with the WANO-MC and as part of the ATOMEXPO-2012 International Forum, will hold a special event entitled “Post-Fukushima Nuclear Power with the Operator’s Eyes”.

The following OSART missions are planned:

- to the Kola NPP in the 4th quarter of 2014.
- to the Novovoronezh NPP in the 3rd quarter of 2015.
- to the Smolensk NPP in 2013 (OSART inspection mission).

Based on the WANO General Assembly resolutions, the following activities are planned by Rosenergoatom for 2012:

1. Implementation of the joint project “Preparation and the Holding of the 2013 General Assembly in Moscow” (the host party is Rosenergoatom, and the customer is the WANO-MC).
2. Establishment of the Regional Crisis Center (RCC) for the VVER NPPs based on Rosenergoatom’s Crisis Center.
3. Participation of Rosenergoatom’s experts in the activities of the WANO international project teams working on the implementation of specific recommendations from the Mitchell Commission on 12 directions.
4. Formation of the WANO’s institution of representatives at the Russian NPP sites.

In 2012 the WANO peer reviews are scheduled for Beloyarsk and Kola NPPs, and follow-up peer reviews are scheduled for Rostov and Kalinin NPPs. A follow-up corporate peer review is also scheduled by the WANO for Rosenergoatom.

In total, as shown in Rosenergoatom's cooperation schedules, in 2012 there will be 80 actions taken jointly with the WANO and 65 actions taken jointly with the IAEA.

For 2012, the plans envisage the participation of Russian experts in mutual audits to be held by NAEC Energoatom with respect to the use of symptom-oriented emergency procedures at Rovno NPP (in March) and at Khmelnitsky NPP (in August).

6.2.c Preliminary or final results of the Operator's activities, including proposals on further actions

The implementation of a large-scale nuclear power development program was continued in Russia in 2011. The accident at the Fukushima-Daiichi NPP has not led to a slowdown in the Russian nuclear power evolution pace, still has called for a closer look to be taken at the safety of NPPs to prevent such events from happening in future. In Russia, the lessons that can be learned from this accident are scrutinized and respective steps for upgrading the NPP safety are being taken. Another current development factor is that there is an increasingly growing number of countries that have embarked on the path of building their own nuclear power, including countries set at implementing or/and implementing Russian reactor technologies. All this places a greater emphasis on the Russian operator's international cooperation as the tool to coordinate all their respective activities with the activities of the international community for the purpose of safe and sustained evolution of nuclear electricity generation.

6.3. Actions taken by the Regulator

6.3.a Overview of the Regulator's actions taken or planned

Mechanism of communicating with neighboring states and the international community

A good practical example of the mechanisms of communicating with neighboring states, which are efficiently employed by Rostechnadzor, are operating safety audits that are held traditionally at Russian NPPs (Leningrad and Kola) jointly with Finland's Center for Radiation and Nuclear Safety (STUK), in which it takes part as an observer, and regular working meetings (biannual) of Rostechnadzor and STUK inspectors, which are focused on exchange of information regarding operation and in-service safety supervision at Russian and Finnish NPPs, including information on the events occurred at the given nuclear installations.

These good practices are expected to be extended to cooperation with regulators of other countries.

In 2012 Rostechnadzor plans to inspect one of the Russian NPPs jointly with the French nuclear safety authority, Autorité de Súrete Nucléaire, ASN, and take part, upon invitation from ASN, in an inspection at a French NPP. It is also planned that a working meeting will be held with ASN to exchange information on the events occurred at Russian and French nuclear installations, including on results of analyses of causes for those events and respective corrective measures.

In 2012 Rostechnadzor plans to convene a number of workshops for exchange of information on the additional analysis of the NPP protectiveness against extreme external impacts with the Finnish regulator STUK and

France's ASN (regulator) and EDF (operator) with participation of Rosenergoatom.

Cooperation with international organizations and associations.

Participation in task groups

Cooperation with the IAEA

Representatives of Rostechnadzor are members of the IAEA Commission on Safety Standards and the IAEA Nuclear Safety Standards Committee, and act as observers in all IAEA committees.

Rostechnadzor has taken an active part in the IAEA Forum on Cooperation of Regulatory Authorities, and, through its technical support organizations, has participated in the TSO Cooperation Forum.

As part of the IAEA national project, Rostechnadzor gives support to the regulatory authority of Armenia.

Cooperation with the OECD's Nuclear Energy Agency

As part of its cooperation with the OECD/NEA, in 2011 Rostechnadzor took part in the activities of the OECD/NEA's Nuclear Regulation Committee (NRC) and the proceedings of its task groups, in particular in the activities of the Senior-Level Working Group formed to analyze the lessons learned from the accident at Fukushima-Daiichi NPP.

During the Forum, convened by the OECD/NEA NRC in June 2011 and devoted to the events at Fukushima-Daiichi NPP, a report was delivered by Rostechnadzor on the actions taken in the Russian Federation given the lessons of the Fukushima accident, as well as on its plans for further expansion of the international cooperation in the field of nuclear and radiation safety regulation.

Also, in 2011, Rostechnadzor experts took part in other international meetings convened to review the lessons from the accident at Fukushima-Daiichi NPP and discuss approaches to the additional analysis of the Russian NPP degree of protection:

- participation in an open collegium session of Ukraine's State Nuclear Regulatory Committee for discussion of the Ukrainian NPP protectiveness additional analysis results;
- discussion of approaches to the expert reviews of the additional analysis results with the ENSREG task group;
- participation in the IAEA workshops concerned with reviewing the lessons from the accident at Fukushima-Daiichi NPP.

International missions

IAEA

The lessons learned from the accident at the Japanese Fukushima-Daiichi NPP demonstrate again the importance of having a competent and independent regulatory body possessing the required financial and human resources for the efficient implementation of government functions in the field of regulation of the uses of atomic energy, as set forth in the IAEA documents adopted as the result of the International Conference on Nuclear Safety (20-24 June 2011) and of the 55th Session of the IAEA General Conference (19-23 September 2011).

A tool that helps to determine the efficiency of a nuclear safety regulatory authority is the IAEA safety regulator evaluation mission.

As the result of the IAEA mission in the Russian Federation and the recommendations and proposals developed, Rostechnadzor has developed the Action Plan, which contains 46 measures to be taken in 2012.

The action plan status was reported at the IAEA workshop on the lessons learned from the IAEA regulator evaluation mission held in Washington in October 2011. The next such event will take place in Russia in 2014.

As required by the IAEA procedure, the Agency's follow-up mission is scheduled for 2013 to review how efficiently the recommendations from the previous IAEA mission are fulfilled for the purpose of assessing the regulatory body activities.

Cooperation on operating experience

Rostechnadzor has proposed that it will assist, where required, the regulatory bodies of Armenia, China and Iran with reviewing the reports on the additional analysis of the NPP protectiveness against extreme external impacts.

Rostechnadzor's experts are users of the IAEA-administrated IRS database on events that have taken place at nuclear installations.

Use of the IAEA safety standards

The IAEA safety requirements and guides are broadly used by Russian experts to develop national regulatory documents at all levels.

The demonstration of the fact is that the extensive use of national regulatory documents was noted as an aspect of the existing good practice by the Agency's regulator efficiency assessment mission held in 2009 on the Russian Government request, and that 75 IAEA standards and guides were used to prepare in 2001 for the OSART mission to Smolensk NPP.

6.3.b Information on time schedules and measures planned

Rostechnadzor will continue to carry out the international cooperation both on a multilateral and a bilateral basis.

Rostechnadzor plans to review its participation in international events and in activities by international organizations in 2012, the results of which will be used to develop proposals on raising the efficiency of international cooperation and improving nuclear and radiation safety regulation for the peaceful use of atomic energy with regard for the experience of foreign partners.

6.3.c. Regulator’s conclusions

The Russian Federation’s control authority, operator and nuclear and radiation safety regulator carry out active international cooperation, both on a multilateral and bilateral basis, for the purpose of improving the safety of Russian NPPs, as well as the safety of NPPs built in other countries to Russian designs.

A near-term top-priority task of the Russian Federation, as far as international cooperation in the nuclear field is concerned, is to provide counseling support for and strengthen the nuclear power infrastructure in the countries planning to build or already building nuclear installations based on Russian designs.

6.4. Summary table

Activity	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 2a) Completed? Ongoing? Planned?	(Item 2b) Schedule or milestones for planned activities	(Item 2c) Results available Yes? No?	(Item 3a) Taken? Completed? Planned?	(Item 3b) Schedule or milestones for planned activities	(Item 3c) Findings available Yes? No?
Making proposals on amendments to the Convention on Nuclear Safety				Completed	Not applicable. Completed in 2011.	Yes
Joint safety inspections of Russian nuclear plants, involving foreign regulators as observers				Planned if there is mutual agreement between regulators	In 2011 Armenian experts took part as observers in the Kola NPP inspection. In 2012 joint inspections with the French regulator are planned	Yes
Participation in the IAEA Safety Standards Committees and Commission	Carried out on a regular basis		Yes	Carried out on a regular basis		Yes
Participation in the Regulatory Cooperation Forum				Carried out on a regular basis		Yes
Participation in the TSO Forum				Planned on a regular basis		No
Hosting the IAEA's OSART missions	Planned on a regular basis	In 2011 there was an OSART mission to the Smolensk NPP. In 2014 an OSART mission to the Kola NPP is planned. In 2013 an inspection visit to the Smolensk NPP is panned	Yes No No			

Activity	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 2a) Completed? Ongoing? Planned?	(Item 2b) Schedule or milestones for planned activities	(Item 2c) Results available Yes? No?	(Item 3a) Taken? Completed? Planned?	(Item 3b) Schedule or milestones for planned activities	(Item 3c) Findings available Yes? No?
			No			
Participation in the IAEA Conference on Nuclear Safety in Japan		Planned for December 2012			Planned for December 2012	No
Hosting on-the-job trainees sent in by the IAEA				Ongoing	On-the-job trainees received in 2011. Reception of more on-the-job trainees is planned in future	No
Establishment of Rosenergoatom's integrated regional crisis center to support decision-making on severe accidents	Planned	Expected in 2012	No			
Participation in the OECD/NEA NRC activities				Ongoing and planned for future		Yes
Participation in the OECD/NEA task group on exchange of experience				Ongoing and planned for future		Yes
Cooperation with Iran and China on the additional analysis for the Russian-designed NPPs	Ongoing	Expected to be completed in 2012	No	A proposal of assistance in carrying out the additional analysis of the NPP intrinsic safety against extreme external impacts	If there is a respective positive response	No

Activity	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 2a) Completed? Ongoing? Planned?	(Item 2b) Schedule or milestones for planned activities	(Item 2c) Results available Yes? No?	(Item 3a) Taken? Completed? Planned?	(Item 3b) Schedule or milestones for planned activities	(Item 3c) Findings available Yes? No?
Participation in the WANO peer reviews	Ongoing and planned for future	The operator peer reviews were conducted in 2011, as well as for the Balakovo, Beloyarsk and Novovoronezh NPPs. Peer reviews are planned in 2012 г for the Beloyarsk, Kalinin, Kola and Rostov NPPs. An in-house operator audit is planned for 2013	Yes			
IRSS mission in the Russian Federation				Completed and planned for future	As the result of the 2009 mission, an action plan was prepared (46 actions). Expected to be completed in 2012. For 2013 the follow-up IRSS mission is planned	No
Giving support to the regulators in the countries planning the construction of NPPs to Russian designs				Ongoing for Vietnam and planned for Turkey, Belorussia and Bangladesh		No

Activity	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 2a) Completed? Ongoing? Planned?	(Item 2b) Schedule or milestones for planned activities	(Item 2c) Results available Yes? No?	(Item 3a) Taken? Completed? Planned?	(Item 3b) Schedule or milestones for planned activities	(Item 3c) Findings available Yes? No?
Participation in the OECD/NEA NRC activities				Ongoing and planned for future		Yes
Participation in the OECD/NEA task group on exchange of experience				Ongoing and planned for future		Yes
Cooperation with Iran and China on the additional analysis for the Russian-designed NPPs	Ongoing	Expected to be completed in 2012	No	A proposal of assistance in carrying out the additional analysis of the NPP intrinsic safety against extreme external impacts	If there is a respective positive response	No
Participation in the WANO peer reviews	Ongoing and planned for future	The operator peer reviews were conducted in 2011, as well as for the Balakovo, Beloyarsk and Novovoronezh NPPs. Peer reviews are planned in 2012 г for the Beloyarsk, Kalinin, Kola and Rostov NPPs. An in-house operator audit is	Yes			

Activity	Activities performed by the Operator			Activities performed by the Regulator		
	(Item 2a) Completed? Ongoing? Planned?	(Item 2b) Schedule or milestones for planned activities	(Item 2c) Results available Yes? No?	(Item 3a) Taken? Completed? Planned?	(Item 3b) Schedule or milestones for planned activities	(Item 3c) Findings available Yes? No?
		planned for 2013				
IRSS mission in the Russian Federation				Completed and planned for future	As the result of the 2009 mission, an action plan was prepared (46 actions). Expected to be completed in 2012. For 2013 the follow-up IRSS mission is planned	No
Giving support to the regulators in the countries planning the construction of NPPs to Russian designs				Ongoing for Vietnam and planned for Turkey, Belorussia and Bangladesh		No

Conclusions

1. At NPPs operated in the Russian Federation, requirements of the legislation and federal standards and rules in the field of the use of atomic energy in effect in Russia are observed.
2. The short-term, mid-term and long-term NPP safety enhancement measures developed by Rosenergoatom basing on results of the additional analyses of protection of the Russian operating NPPs against external extreme impacts and controlled by Rostechnadzor are justified and sufficient.
3. It is deemed reasonable to carry out an additional analysis of protection against external extreme natural and man-induced impacts for Russian NPPs being constructed and sited.
4. It is deemed reasonable to refine the Russian regulatory basis in the field of the use of atomic energy basing on the results of the additional analysis of protection of NPPs carried out.
5. It is deemed reasonable to develop a "Program of Measures of Participation of the Russian Federation in Implementation of the IAEA Nuclear Safety Action Plan" with involvement of the Ministry of Foreign Affairs of the Russian Federation, the State Atomic Energy Corporation ROSATOM, the Federal Environmental, Industrial and Nuclear Supervision Service, the Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters, Federal Medical Biological Agency, and the Federal Service for Supervision of Consumer Rights Protection and Human Welfare.

Director General of the State
Atomic Energy Corporation
ROSATOM

S.V. Kirienko

Chairman of the Federal
Environmental, Industrial and
Nuclear Supervision Service

N.G. Kutiyn

Appendix 1

Table P.1.1 gives main data of the operating Russian NPP units.

Table P.1.1

Main data of the operating Russian NPP units

NPP	Number of units	Commissioning year	RI type	Rated electric power, MW	Operating license expiry date
Balakovo	4	1: 1985 2: 1987 3: 1988 4: 1993	VVER-1000 VVER-1000 VVER-1000 VVER-1000	1000 1000 1000 1000	2015 2017 2018 2023
Bilibino	4	1: 1974 2: 1974 3: 1975 4: 1976	EGP-6	12 12 12 12	2019 2019 2020 2021
Beloyarsk	1	3: 1980	BN-600	600	2025
Kalinin	4	1: 1984 2: 1986 3: 2004 4: 2011	VVER-1000	1000 1000 1000 1000	2014 2016 2019 2041
Kola	4	1: 1973 2: 1974 3: 1981 4: 1984	VVER-440	440 440 440 440	2018 2019 2016 2014
Kursk	4	1: 1976 2: 1979 3: 1983 4: 1985	RBMK-1000	1000 1000 1000 1000	2016 2019 2028 2030
Leningrad	4	1: 1973 2: 1975 3: 1979 4: 1980	RBMK-1000	1000 1000 1000 1000	2013 2015 2024 2025
Novovoronezh	3	3: 1971 4: 1972 5: 1980	VVER-440 VVER-440 VVER-1000	440 440 1000	2016 2017 2015
Rostov	2	1: 2001 2: 2010	VVER-1000	1000 1000	2020 2040
Smolensk	3	1: 1982 2: 1985 3: 1990	RBMK-1000	1000 1000 1000	2012 2015 2020

Each power unit in operation includes an at-reactor storage of spent nuclear fuel (spent fuel pool, SFP). At-reactor spent fuel pools are used for SNF wet storage (in water), exclusive the SFPs at Bilibino-1,2, where SNF dry storage is used. There is no spent fuel currently in storage in the SFP of Bilibino-4 commissioned in 2010.

Kursk, Leningrad, Smolensk and Novovoronezh NPP sites have standalone storage facilities, which are used for wet storage of spent nuclear fuel. Wet storage of spent nuclear fuel in spent fuel pools is used at Beloyarsk-1,2, which have been shut down for decommissioning. There is no nuclear fuel at Novovoronezh-1,2 also shut down for decommissioning.

Table P.1.2 gives the extent, to which the standalone SNF storage facilities are filled at Russian NPPs as of 2011 (including the spent fuel pools of shutdown Beloyarsk-1,2).

Table P.1.2.

Filling extent of standalone spent nuclear fuel storage facilities

NPP	Design capacity	Volume actually filled
Beloyarsk	6,920	4,994
Kursk	35,040	34,799
Leningrad	38,160	35,058
Novovoronezh	629	208
Smolensk	35,540	21,416

NPPs with the VVER-1000, VVER-440 and BN-600 reactors have fuel removed, following the cooling in the at-reactor SFPs, to the Mining and Chemical Combine and PA Mayak for reprocessing.

At NPPs with the RBMK-1000 and EGP-6 reactors, spent nuclear fuel is currently stored on the NPP sites (in spent fuel storage facilities and at-reactor SFPs at the RBMK NPPs and in SFPs at Bilibino NPP) and is not shipped off. Intermediate container-type spent nuclear fuel dry storage facilities are under construction at the Kursk, Leningrad and Smolensk NPPs. Removal of spent fuel, held up for over 10 years in the at-reactor pools, has begun at the Leningrad NPP.

Appendix 2

Categorization of NPP components in terms of safety significance (an excerpt from para. 2.5 of OPB-88/97)

In terms of safety significance, four safety classes of the NPP components are identified.

Safety class 1 includes the fuel rods and NPP components, which failures are initiating events of beyond design basis accidents leading, with the safety systems operating as required by the design, to fuel rod damage in excess of the limits set forth for design basis accidents.

Safety class 2 includes the following NPP components:

- components, which failures are the initiating events leading to fuel rod damage within the limits set forth for design basis accidents, with the safety systems operating as required by the design, given the number of failures therein as specified by regulations for design basis accidents;
- components of safety systems, which single failures lead to a failure of the respective systems to perform their functions.

Safety class 3 includes NPP components:

- of safety-important systems, other than of safety classes 1 and 2;
- that contain radioactive substances, which release into the environment (including the NPP process rooms) during failures exceeds the values set forth by the radiation safety standards;
- that perform radiation protection monitoring functions with regard to the personnel and public.

Safety class 4 includes NPP components of normal operation, which do not affect safety and other than that of safety classes 1, 2 and 3.

Safety class 4 also includes components, used for accident management, other than that of classes 1, 2 and 3.

Appendix 3

Table P.3.1 gives main data of the Russian NPP auxiliary power supply systems.

Table P.3.1

Main data on the Russian NPP auxiliary power supply systems (as of 2011)

NPP	NPP connection to the grid, connections of units	EPS system characteristics (number of channels), number of DGs and SBs
Balakovo-1,2,3,4	The connection to the grid is at two voltages – 220 kV (5 lines) and 500 kV – (5 lines). The connection between the OSG using a three-phase group of single-phase automatic transformers. In-house power is supplied from two working in-house transformers connected to the generator current leads of 24 kV. The working in-house transformers are backed up using two standby transformer groups of two transformers each. Group 1 of standby in-house transformers is connected to the 220 kV outdoor switchgear. Standby transformer group 2 is connected to the medium voltage (220 kV) winding of the automatic transformer, which enables power supply to the standby transformer from the 500 kV outdoor switchgear when the 220 kV outdoor switchgear fails.	Three independent channels per unit There is an SDPS in each channel
Beloyarsk-3	The connection to the grid is via two outdoor switchgears of 220 kV (5 lines) and 110 kV (8 lines). In-house power is supplied via three working in-house transformers or standby in-house transformers connected to the 110 kV outdoor switchgear.	3 independent channels per unit There are two SDPSs in each channel
Bilibino-1,2,3,4	The connection to the grid is via the indoor switchgear of 110 kV (3 lines). In-house power is supplied via the unit transformers and electrical reactors of the RBAM-6-400-3 type or via the standby transformer.	3 independent channels Channel 1 is shared by units 1 and 2 Channel 2 is shared by

NPP	NPP connection to the grid, connections of units	EPS system characteristics (number of channels), number of DGs and SBs
		units 3 and 4 Channel 3 is shared by units 1, 2, 3 and 4 There is an SDPS in each channel
Kalinin-1,2,3,4	The NPP connection to the grid is via the outdoor switchgears of 330 kV (4 lines) and 750 kV (5 lines), the connection between which is via an automatic transformer with a backup phase. In-house power supply for each unit is via unit transformers or standby transformers connected to the 330 kV outdoor switchgear.	3 independent channel per unit There is an SDPS in each channel There are 2 SDPSs of normal operation shared by units 3 and 4
Kola-1,2,3,4	The connection to the grid is via the 330 kV outdoor switchgear (5 lines). In-house power supply for each unit is via in-house transformers or from 2 standby transformers, one of which is connected to the 110 kV line and the other to two 154 kV lines. An alternative power source (Niva-1 Hydro) supplies power via 110 kV ETL, from which in-house power can be supplied via a standby transformer.	3 independent channels at each unit There is an SDPS in each channel There is 1 SDPS of normal operation shared by units 1 and 2
Kursk-1,2,3,4	The connection to the grid is via the outdoor switchgears of 110 kV (2 lines) and 330 kV (6 lines) and two 750 kV outdoor switchgears (3 lines). The 330 kV outdoor switchgear for units 1 and 2 is connected to the 750 kV outdoor switchgear of units 3 and 4 via the 1AT automatic transformer and via the 2AT automatic transformer with the 750 kV outdoor switchgear of phase III. In-house power supply for each unit is via the unit in-house transformers or standby transformers connected to the 330 kV outdoor switchgear.	3 independent EPS channels at each unit. There is an SDPS in each channel. There are 2 SDPSs of normal operation shared by the EPSs of units 1 and 2. There are 2 SS SDPSs for the

NPP	NPP connection to the grid, connections of units	EPS system characteristics (number of channels), number of DGs and SBs
		ECCS-2 power supply, which are shared by units 1 and 2
Leningrad-1,2	The connection to the grid is via the 330 kV outdoor switchgear (3 lines), which is connected, via an AT, to the 750 kV outdoor switchgear. In-house power supply from the 330 kV outdoor switchgear is via the in-house transformers. An alternative power source (Narva Hydro) supplies power to the NPP over two 110 kV power transmission lines, from which in-house power can be supplied via standby transformers.	3 independent EPS channels per unit There is an SDPS in each channel
Leningrad-3,4	The NPP connection to the grid is via the 750 kV outdoor switchgear (1 line), which is connected to the 330 kV outdoor switchgear via an AT. Auxiliary power supply from the 750 kV outdoor switchgear is via in-house transformers. In-house power supply for each unit is via the unit in-house transformers or standby transformers connected to the 110 kV outdoor switchgear. An alternative power source (Narva Hydro) supplies power to the NPP via two 110 kV power transmission lines, from which in-house power can be supplied via a standby transformer.	4 independent EPS channels per unit There is an SDPS in each channel
Novovoronezh	Units 3 and 4 The connection to the grid is via the outdoor switchgears of 110 kV (6 lines), 220 kV (8 lines) and 500 kV (4 lines). In-house power supply for each unit is via in-house transformers or standby transformers connected to the 110 kV and 220 kV outdoor switchgears.	2 independent EPS channels at each unit There are two SDPS in each channel
	Unit 5 The connection to the grid is at two voltages: 220 kV (via 2 automatic transformers) and 500 kV (output power of 500 kV). In-house power supply is via auxiliary transformers or a standby transformer connected to the 220 kV outdoor switchgear.	3 independent EPS channels There is an SDPS in each channel

NPP	NPP connection to the grid, connections of units	EPS system characteristics (number of channels), number of DGs and SBs
Rostov	The connection to the grid is via outdoor switchgears of 220 kV (2 lines) and 500 kV (5 lines). The connection between the 220 kV outdoor switchgear and the 500 kV outdoor switchgear is over a 220 kV cable via the AT1 automatic transformer. In-house power is supplied tor each unit via in-house transformers or by a group of two standby in-house transformers connected to the 220 kV outdoor switchgear.	3 independent EPS channels at each unit There is an SDPS in each channel
Smolensk	Units 1 and 2. The connection to the grid is via outdoor switchgears of 330 kV (2 lines) and 500 kV (2 lines). In-house power supply is via in-house transformers or a standby transformer connected to the 330 kV outdoor switchgear.	3 independent EPS channels per unit There is an SDPS in each channel
	Unit 3. The connection to the grid is via the 750 kV outdoor switchgear (2 lines). In-house power supply is via in-house transformers or a standby transformer connected to the 330 kV outdoor switchgear.	

Table P.3.2 presents engineered features available at Russian NPPs for the management of beyond design basis accident involving the NPP blackout.

Table P.3.2.

Available engineered features for the management of beyond design basis accidents involving the NPP blackout (as of 2011)

NPP	Engineered features for management of beyond design basis accidents involving NPP blackout
Bilibino	PAES-2500 gas-turbine plant
Kola	A mobile emergency diesel generator station (2000 kV), with the actuation time not more than 5 hours.
Novovoronezh	Fixed emergency diesel generator station.
Kalinin, Kola, Kursk	An SDPS of normal operation can be used.

Appendix 4

Table P.4.1 presents basic flowcharts of heat removal to the ultimate heat sink at Russian NPPs.

Table P.4.1.

Basic flowcharts for heat removal to the ultimate heat sink at Russian NPPs

NPP	Heat removal paths to ultimate heat sink
Balakovo-1,2,3,4	*From reactor cores* 1) The primary water transfers heat to the secondary circuit via steam generators. The secondary water is fed to the SGs, after which the heated steam is discharged to the atmosphere or transfers heat to the circulating water (ultimate heat sink) in the turbine condenser. 2) The primary water, when the scheduled cooldown system is in operation, transfers heat to water in the service water system of group “A”, which, through the operation of spraying pools, transfers heat to the atmosphere (ultimate heat sink). *From spent fuel pools* The SFP water is cooled by the cooldown system, which transfers heat to the water in the service water system of group “A”, which through the operation of spraying pools, transfers heat to the atmosphere (ultimate heat sink).
Beloyarsk	*From reactor core of unit 3* The primary and secondary circuit coolant is sodium, and the tertiary circuit coolant is water. The ultimate heat sink, under normal conditions, is the Beloyarsk water reservoir. During normal and emergency core heat removal, the emergency cooldown system is in operation, which removes heat thanks to the water inventory in the circulation (tertiary) circuit and in the pure condensate tanks. In the steam mode of the steam generator operation, steam is discharged to the atmosphere, with the water circulating in the tertiary circuit via the turbine condenser and the deaerator after the steam generator changes to the water mode. At present time, there is an additional system installed for the secondary circuit cooldown via an air-cooled heat exchanger, which will be used in the event of the emergency cooldown system failure. *From spent fuel pools of units 1 and 2* The spent fuel pools at Beloyarsk-1,2 finally shut down to be further decommissioned do not require cooling. The natural water loss as the result of evaporation is compensated by the by the fire water system.

<table>
<tr><th>NPP</th><th>Heat removal paths to ultimate heat sink</th></tr>
<tr><td></td><td> From spent fuel pools of unit 3
At unit 3, spent fuel is placed in the SFA drum and then in the SFP, which are cooled by the service water supply system.
In an emergency mode, heat is removed from the BN-600 reactor SFA drum by an air-cooled heat exchanger. SFP-3 is cooled by the fire water system. </td></tr>
<tr><td>Bilibino</td><td> From the reactor core
In the core cooldown mode, excessive heat is removed from the DS, via the regulator stations, to the turbine condenser or to the main boiler cooled by service water.
Heat is removed from the shutdown reactor by the maintenance cooldown system. Residual heat is transferred to the service water in the maintenance cooldown heat exchanger.
The service and circulating water circuits are cooled by air radial coolers (ARC) with the heat removal to the atmosphere (ultimate heat sink).
For cases where no standard cooldown flowcharts can be used, the following heat removal paths from the core to the ultimate heat sink are provided:

steam discharge to the atmosphere via the main steam valve (MSV);
to the deaerator through the CPS channels cooling circuit with steam discharge, where appropriate, to the atmosphere via the deaerator hydraulic gate;
to the biological shielding tank cooled by service water;
by exhaust ventilation systems from the inter-reactor cavity;
(during a ‘wet’ accident) steam-gas mixture discharge from the reactor cavity to the bubbler tank and further to the atmosphere;
from the surfaces of components to process rooms through heat losses.

From spent fuel pools of units 1 and 2 (SFP-1,2)
Heat is removed from ‘dry’ SFP-1,2 by exhaust ventilation systems. The air from SFP-1,2 is purified in mixed-bed filters and in aerosol filters and is discharged further through the stack. Air gets into SFP-1,2 from the central hall room thanks to the vacuum created by the exhaust systems.
From the spent fuel pool of unit 3
Heat is removed from SFP-3 by the SFP-3 cooling, purification, filling and evacuation system. The SFP cooling water transfers heat via heat exchangers to the service water, which transfers heat to the atmosphere via the ARCs. </td></tr>
<tr><td>Kalinin-1,2</td><td> One of the following paths is used to remove heat to the ultimate heat sink:
From reactor core

The primary circuit water transfers heat to the secondary circuit via steam generators. The secondary circuit water is fed to the SGs, after which the heated steam is discharged to the atmosphere, or transfers heat to the circulating water in the turbine condensers, which transfers heat to the atmosphere (ultimate heat sink) via cooling towers.
</td></tr>
</table>

<table>
<tr><th>NPP</th><th>Heat removal paths to ultimate heat sink</th></tr>
<tr><td></td><td>2) The secondary circuit water, when the scheduled cooldown system is in operation, transfers heat to the water in the service water system of group ‘A’, which transfers heat to the lake (ultimate heat sink).
From spent fuel pools

The SFP water is cooled by the cooldown system, which transfers heat to the water in the service water system for essential consumers, which is discharged into the lake (ultimate heat sink)</td></tr>
<tr><td rowspan="2">Kalinin-3,4</td><td>One of the following paths is used to remove heat to the ultimate heat sink:

From reactor core of unit 3

1) The primary circuit water transfers heat to the secondary circuit via steam generators. The secondary circuit water is fed to the SGs, after which the heated steam is discharged to the atmosphere, or transfers heat to the circulating water (ultimate heat sink) in the turbine condensers.
2) The secondary circuit water, when the scheduled cooldown system is in operation, transfers heat to the water in the service water system of group ‘A’, which transfer heat, through the operation of spraying pool, to the atmosphere (ultimate heat sink).
From spent fuel pools of unit 3

The SFP water is cooled by the cooldown system, which transfers heat to the water in the service water system of group ‘A’, which transfers heat, through the operation of spraying pools, to the atmosphere (ultimate heat sink).</td></tr>
<tr><td>One of the following paths is used to remove heat to the ultimate heat sink:

From reactor core of unit 4

1) The primary water transfers heat to the secondary circuit via steam generators. The secondary water is fed to the SGs, after which the heated steam is discharged to the atmosphere, or transfers heat to the circulating water (ultimate heat sink) in the turbine condensers.
2) The secondary water, when the scheduled cooldown system is in operation, transfers heat to the water of the service water system of group ‘A’, which transfers heat to the lake (ultimate heat sink).
From spent fuel pools of unit 4

The SFP water is cooled by the cooldown system, which transfers heat to the water in the service water system of group ‘A’, which transfers heat to the lake (ultimate heat sink).</td></tr>
</table>

NPP	Heat removal paths to ultimate heat sink
Kola-1,2,3,4	One of the following paths is used to remove heat to the ultimate heat sink: *From the reactor cores* 1) The primary water transfers heat to the secondary circuit via steam generators. The secondary water is fed to the SGs, after which the heated steam is discharged to the atmosphere, or transfers heat to the circulating water (ultimate heat sink) in the turbine condensers. 2) The feed & bleed procedure can be organized, in which the makeup system (or ECCS) feeds water to the primary circuit. The water heated in the core is discharged via the pressurizer's pilot-operated relief valve (PORV P), after which comes into the containment sump and into the sprinkler heat exchanger, where it transfers heat to the service water of essential consumers, which is discharged, in turn, to the lake (ultimate heat sink). *From spent fuel pool* The SFP water is cooled by the cooldown system, which transfers heat to the water in the service water system for essential consumers, which is discharged into the lake (ultimate heat sink).
Kursk-1,2,3,4 Leningrad-1,2,3,4 Smolensk-1,2,3	*From reactor cores* In the cooldown mode, when the reactor is shut down, excessive steam is removed from the DS to the turbine condensers via the BRU-K. The differences in the way steam is removed from the DS in the cooldown mode, when the reactor is shut down, are determined for the RBMK units by the following devices available at the NPPs: • the steam dump devices at the Kursk NPP include BRU-A, BRU-D and BRU-K, via which excessive steam can be dumped from the DS. The DS levels are maintained by the system for the reactor makeup from normal-operation or emergency systems; • at the Leningrad NPP, steam can be dumped into the ESCS (emergency steam condensation system) bubbler tanks via the BRU-K; • at the Smolensk NPP, heat can be removed from the main circulation circuit (MCC) by dumping steam from the DS via the BRU-D and the BRU-K, with the DS levels maintained by the reactor water makeup system. In conditions of accidents leading to the vacuum break in the turbine condensers, steam is dumped from the DS to the accident localization system (ALS) via the MSV. Heat is removed from the ALS to the water in the cooling water reservoir (ultimate heat sink) by the service water via heat exchangers. The reactor and the MCC are cooled in the water mode during scheduled and emergency shutdown of the unit also by the blowdown and cooldown system (B&CS). The emergency (accelerated) reactor and the MCC cooldown is by a DS pressure reduction

NPP	Heat removal paths to ultimate heat sink
	thanks to controlled steam discharge from the DS and the subsequent connection of the cooldown pump (CP), with the heat removed from the coolant to the intermediate circuit water in the aftercooler. The intermediate circuit water is cooled by the service water through the pumping and heat exchange plant. Normal cooldown of the reactor and the MCC takes place after the TG disconnection through a smooth DS pressure reduction, at normal water levels, thanks to controlled steam discharge from the DS and removal of heat to the B&CS. The water flow for the blowdown in the MCC (reactor) cooldown mode is achieved by the actuation of one cooldown pump. Blowdown water is taken from the MCP pressure headers or from the DGH dead-end area headers or from the SD water connections. The blowdown water goes back to the DS over feedwater pipelines. Some of the core heat can be removed using the CPS cooling circuit. In case of a blackout accident, the Smolensk NPP emergency response documentation provides for the personnel actions for organizing the reactor facility air cooling with the natural circulation of the DS room air coming in through the explosion relief panels and hot room doors. In this case, heat is removed from a large heat-exchange surface of bare steam-water lines to the atmospheric air (passive heat removal channel). *From spent fuel pools* Water of the near-reactor SFPs is cooled using a system of pumping and heat exchange plants over a closed circuit via heat exchangers cooled by service water (ultimate heat sink). In an emergency, the SFPs are cooled over an open circuit by exchange of water, which is fed to the SFPs over the makeup pipeline and discharged to the drain water reservoir over the overflow pipeline.
Novovoronezh	*From reactor cores of units 3 and 4* 1) The primary circuit water transfers heat to the secondary circuit via steam generators. The secondary circuit water is fed to the SGs, after which the heated steam is discharged to the atmosphere, or transfers heat to the circulating water (ultimate heat sink) in the turbine condensers. 2) The feed & bleed procedure can be organized, in which the makeup system (or ECSS) feeds water to the primary circuit. The water heated in core is discharged via the pressurizer's PSV, after which comes into the containment sump and into the sprinkler heat exchanger, where it transfers heat to the service water of essential consumers, which is discharged, in turn, into the open channel (ultimate heat sink). *From spent fuel pools of units 3 and 4* The SFP water is cooled by the cooldown system, which transfers heat to the water in the service water system for essential consumers, which is discharged into the open channel (ultimate heat sink).
	From reactor cores of unit 5 1) The primary water transfers heat to the secondary circuit via steam generators. The secondary water is fed to the SGs, after which the heated steam is discharged to

NPP	Heat removal paths to ultimate heat sink
	the atmosphere, or transfers heat to the circulating water (ultimate heat sink) in the turbine condensers. 2) The feed & bleed procedure can be organized, in which the makeup system (or ECSS) feeds water to the primary circuit. The water heated in core is discharged via the pressurizer's PSV, after which comes into the containment sump and into the sprinkler heat exchanger, where it transfers heat to the service water of essential consumers, which is discharged, in turn, into the water reservoir (ultimate heat sink). *From the spent fuel pools of unit 5* 3) The SFP water is cooled by the cooldown system, which gives heat to the water in the service water system for essential consumers, which is discharged into the water reservoir (ultimate heat sink).
Rostov	*From reactor cores* 1) The primary circuit water transfers heat to the secondary circuit via steam generators. The secondary circuit water is fed to the SGs, after which the heated steam is discharged to the atmosphere, or transfers heat to the circulating water (ultimate heat sink). 2) The secondary circuit water, when the scheduled cooldown system is in operation, transfers heat to the water in the service water system of group 'A', which transfers heat, through the operation of spraying pools, to the atmosphere (ultimate heat sink). *From spent fuel pools* The SFP water is cooled by the cooldown system, which transfers heat to the water in the service water system of group 'A', which transfers heat, through the operation of spraying pools, to the lake (ultimate heat sink).

Table P.4.2 lists the engineered features available at Russian NPPs for the management of beyond design basis accidents involving the loss of heat removal to the ultimate heat sink.

Table P.4.2.

Engineered features for the management of beyond design basis accidents involving the loss of heat removal to the ultimate heat sink

NPP	Engineered features for management of beyond-design-basis accident involving the loss of heat removal to the ultimate heat sink
Kola	An additional system for supply of water to the steam generators with diesel-operated pumping sets (3 DPSs, 2 water inventory tanks of 500 m^3 with a capability of replenishing the water inventory, the system's pressure pipelines are connected to three out of six steam generators of each NPP unit).
Novovoronezh	A mobile diesel-operated pumping set (comprises a plunger pump with a capacity of 77 m^3/hours, connected to 3 water inventory tanks of 500 m^3 each).

Appendix 5

List of national organizations that provide scientific and technical support to Rosenergoatom in the NPP safety issues, including emergency response and accident consequences elimination:

General designers of nuclear power plants:

– Atomenergoproekt, Moscow;
– SPb AEP, St. Petersburg;
– NIAEP, Nizhny Novgorod;
– VNIPIET, St. Petersburg;

Chief designers of reactor installations:

– OKB Gidropress, Podolsk;
– OKBM Afrikanotov, Nizhny Novgorod;
– NIKIET, Moscow;

Scientific supervisors:

– NRC Kurchatov Institute, Moscow;
– State Research Center of the Russian Federation – IPPE, Obninsk;

Providers of scientific and technical support:

– IBRAE RAS, Moscow;
– VNIIAES, Moscow;
– NPO Taifun, Obninsk;

Providers of services:

– Atomtekhenergo, Mytishchi (equipment adjustment);
– Atomenergoremont, Mytishchi (equipment repair);
– Izhorskiye zavody, Kolpino.

Appendix 6

Given below are the proposed amendments to the Convention on Nuclear Safety sent by the Russian Federation, acting based on the Convention's Article 32, para. 1, on 2 August 2011 (N5.41.01.Circ) to the Contracting Parties to the Convention for consideration (as per the Convention's Article 34, para. 2 iv).

Proposal 1

For the nuclear safety to be ensured in full, as far as operation of nuclear power installations is concerned, it is of the fundamental importance to assess regularly their safety level and take steps to enhance the safety of earlier commissioned nuclear power installations.

It is also important to formalize the obligation of the Contracting Parties to the Convention, who are planning to initiate the construction of the first nuclear installation under their jurisdiction, to take, prior to the NPP construction, all required steps for the long-term planning and establishment of the nuclear power infrastructure in accordance with the IAEA recommendations.

In this connection, the following amendments and additions were proposed to the Convention's Article 2. Existing Nuclear Installations:

1) Article 6 of the Convention shall be revised as follows:

"1. Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible ***and the level of their safety is further regularly assessed***. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements and ***steps*** are made as a matter of urgency to upgrade the safety of the ***earlier commissioned*** nuclear installations. If such upgrading cannot be achieved, plans shall be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact".

2) Paragraph 2 shall be added to Article 6 of the Convention that reads as follows:

"2. The Contracting Party planning to launch the construction of a nuclear installation under its jurisdiction shall take prior to the construction of such installation all necessary steps for long-term planning and establishment of the required infrastructure in accordance with the IAEA recommendations".

Proposal 2

Large-scale accidents are extremely rare at nuclear facilities. Scale and consequences of such accidents are however highly dramatic in terms of adverse impacts on human health and the environment. The state should evidently direct all its resources to assist the NPP operator (utility) in minimizing its adverse consequences.

Given the actual responsibility of the nuclear installation operator for ensuring nuclear safety and the absence in the body of international legal requirements of the standards that govern the participation of the state in the accident management, there should be well-defined regulations for coordination and interaction of the state, the operator and the regulator. Besides, nuclear safety should be regularly assessed based on the IAEA standards.

In this connection, the proposal was that amendments and additions should be made to Articles 7, 14 and 16 of the Convention.

1) Paragraph 1 of the Convention's Article 7. Legislative and Regulatory Framework shall be revised as follows:

"1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to ensure the safety of nuclear installations ***and coordinate the actions between the government bodies and the nuclear installation operators as far as the accident management and the reduction in the level of its consequences are concerned"***.

2) Paragraph ii of the Convention's Article 14. Assessment and Verification of Safety shall be revised as follows:

"ii) verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions, ***with regard for the IAEA safety standards"***.

Paragraph 1 shall be added to the Convention's Article 16. Emergency Preparedness that shall read as follows:

"1. Each Contracting Party shall ensure that regulations are developed for the joint actions of the government bodies and the operators of the nuclear installations in case of a nuclear accident, proceeding from the necessity of ensuring the sufficient facilities, resources and powers of the respective license holder (or the nuclear installation owner), as required for the efficient accident management and the reduction in the level of its consequences".

3) Paragraphs 1, 2 and 3 of Articles 16 shall be renumbered respectively as 2, 3 and 4.

Proposal 3

An analysis of the latest large-scale accidents at the nuclear facilities shows that such situations may be caused not by one but by more than one factors of both natural and man-induced origin.

The existing design requirements are required to be revised to take into account combinations of external impacts on the nuclear installation and envisage the steps that ensure nuclear safety during such an impact.

In this connection, it was proposed that amendments should be made to Article 18 of the Convention.

1) Paragraph iv shall be added to the Convention's Article 18. Design and Construction, that shall read as follows:

"iv) the design of the nuclear installation should take into account various potential site-specific combinations of unfavorable external natural and man-induced impacts, including their combined impact on the nuclear installation, and provide for ensuring safety in the event of such impact".

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