Convention on Nuclear Safety

National Report

of

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INTRODUCTION

The Republic of Armenia signed the Convention on Nuclear Safety (hereinafter referred to as the CNS) on 20 September 1994 and ratified it on 24 September 1997.

In the Republic of Armenia the CNS is applied to one nuclear installation - the Armenian NPP consisting of two WWER-440 units: at present only the Unit № 2 is operated, the Unit №1 is in a condition of conservation after final shutdown in 1989 (more detailed information about the Armenian NPP is provided in the 5th National Report of the RA under the CNS submitted in September 2010).

The present national report of the Republic of Armenia has been prepared in accordance with the Guidance for National Reports to be submitted for peer review at the 2012 CNS Extraordinary Meeting that will be held at the International Atomic Energy Agency in Vienna, Austria, in August 2012.

Following the accident at the Fukushima Daiichi NPPs the interest of the public, media and the Government in the RA on issues related to nuclear safety has significantly increased. In particular, the RA Government requested the regulatory authority and the operator to increase efforts on nuclear safety and emergency preparedness, as well as to join the EU initiative related to conduct of “stress-tests”. And thus, the ANRA requested Armenian NPP to conduct “stress-test” and expects receiving the licensee report in September 2012. The Armenian NPP with its own efforts and resources already started conducting “stress-test”, when EU expressed its willingness to assist in performing and review of “stress-test” results.

This national report addresses the actions that have been taken and the developments that have been made in the Republic of Armenia following the accident at the Fukushima Daiichi NPPs that were aimed to analyze and evaluate the existing situation and identify areas for potential further improvements in line with the fundamental principle of the continuous strengthening of the nuclear safety.

1. EXTERNAL EVENTS

The Armenian NPP is located in a region of relatively high seismicity that has been affected by destructive earthquakes in the past. Analysis of climatic conditions, soil conditions, vegetation, and also lack of water basins in the vicinity of the Armenian NPP excludes such external events as floods, forest fires, sand storms, disastrous snow and wind loads, etc.

From the volcanic point of view, the Armenian NPP is located on the Shamiram peripheral plateau of the Aragats volcanic region, which was formed during the Upper Pliocene (2.5 million years) - Upper Quaternary (0.4 - 1 million years).

From the seismic point of view, the Armenian NPP is located in the central, relatively low-active part of the Mediterranean-Trans-Asian seismic belt. The significant historical seismic event in the region is the Ararat earthquake of 1840 with 7.4 magnitude and the instrumentally observed - the Spitak earthquake of 1988 with 7.0 magnitude. Analysis of the historical and instrumental seismicity allows assuming that the seismic focuses of many strong (with 5.5 or higher magnitudes) earthquakes of the region are timed to the zones of active faults or are located in their direct vicinity.

The Armenian NPP site (R = 5km) is covered with a thick (400m) mantle of Pliocene-Quaternary lava basalt-andesite rock composition, which serves as the foundation for the main buildings and structures of the plant. Three aquifers (to a depth of 400m) are observed under the site, one of which is located at 85m depth below the surface. There are no landslide slopes, mudflow areas, faults, mining, subsidence soils, karst areas, soils with a load capacity of less than 2 kg/cm^2 in the region where the Armenian NPP is located.

Although the plant safety systems did not suffer any damage during previous seismic events, seismic hazards (earthquakes) have been an important consideration in the design, construction and operation of the Armenian NPP. Consequently, it was widely recognized that the seismic hazard is a major safety issue for the Armenian NPP. For this reason, with the support mainly from EC and USA Department of Energy, and on the basis of the Technical Guidelines prepared by the IAEA in 1997 and approved in March 1999 by the ANRA, the Armenian NPP implemented a comprehensive Seismic Safety Re-Evaluation Programme for the Unit №2 in operation.

The PSA level 1 for external events, internal fire and floods was performed in 2004. The analysis of external events within the PSA level 1 for the Armenian NPP was performed in two stages. At the first stage the list of all possible external initiating events was developed. The low likelihood events at the Armenian NPP were screened out from the list.

The detailed analysis was performed for the following scenarios of external initiating events:

- Snow load on building roofs, which will result in their collapsing and damage of equipment located inside the building;

- Venting stack falling on the main building due to wind load and the primary circuit equipment damage;
- Dust storm resulting in failure of the diesel generator due to dust ingression into the air intake;
- Flooding, due to rain water accumulation on the site resulting in failure of the safe shutdown equipment;
- Explosion of the high pressure cylinder, located at the Armenian NPP site, resulting in damage of the safe shutdown equipment;
- Low temperature of air, resulting in:
    - Blocking of fuel supply to the diesel generator,
    - Water freezing in tubes from the demineralized water tank to the emergency seismic pump;
- High temperature of air resulting in unacceptable conditions for operation of equipment and consequently to its failure;
- Lightning resulting in the electrical equipment damage (transformers, transmission lines etc.)
- Aircraft crash on the Armenian NPP resulting in damage of equipment of the primary and secondary circuits.

The calculation results of external events impacts on the CDF are as follows:

- Dust storms resulting to loss of power supply - 1.8×10^{-5};
- Strong wind - 2×10^{-6}.

At the beginning of March, 2008 ENCONET performed the seismic PSA for the Armenian NPP. The general seismic CDF was assessed to 1,04E-4 events a year. Main groups of scenarios for the core damage frequency are as follows:

- Scenario with loss of external electrical supplies caused by seismic event - 57%;
- Scenario with building failure caused by seismic event - 14%;
- Scenario with the primary circuit rupture caused by seismic event - 12%;
- Scenario with non-isolated secondary circuit rupture caused by seismic event -10%;

- Scenario with transient caused by seismic event - 5%;
- Strong seismic event (earthquake with PGA>0.8g) - 1%.

2. DESIGN ISSUES

The original seismic design basis for the Armenian NPP site was based on studies conducted between 1966 and 1972. Those studies concluded that the maximum earthquake intensity anticipated for the site area was I=7 (equivalent to 0.10g as peak ground acceleration) according to the MSK-64 scale. In compliance with the rules valid at that time, the plant was designed according to the Soviet code for earthquake design for conventional structures and buildings (i.e. SNIP II-A, 12-62) and with additional requirements as they were established in several letters of the former USSR GOSSTROJ (Ministry of Construction) and other Soviet scientific and research institutions.

During development of the Armenian NPP design, in 1972, a recommendation letter was issued by CNIISK (Central Building Research Institute of the former USSR), in which it was recommended to increase the seismic input, using a maximum ground acceleration of 0.40g for the reactor shaft and 0.20g for the reactor compartment at the Reactor Building. These values refer to quasi-static equivalent accelerations as requested by the rules at that time. Accordingly some upgrades were performed for some safety related systems, building structures and components.

The first regulation for seismic design of nuclear power plants in the former USSR was issued in 1987, i.e. the PNAEG 006-87 Standard. Accordingly, the site seismicity was redefined as 8 balls (about 0.20g for the peak ground acceleration) and a reconstruction project for equipment, systems and buildings was launched with that seismic input.

Picture 1. Spray Ponds

Picture 2. Dry Spent Fuel Storage Facility

For emergency situations, the design also provides for the safety system (elements), which ensure residual heat removal from the reactor core, in particular:

- The primary emergency make-up system;
- The high and low pressure reactor emergency cooling systems;
- The SG emergency make-up system;
- The primary overpressure protection system;
- The secondary overpressure protection system;
- The essential service water system;
- The reliable power supply system.

Besides, the above mentioned design systems and the emergency heat removal from the reactor, there are two additional systems, that are designed for emergency core cooling during management of beyond design basis accidents, these are:

- The SG auxiliary make-up system (diesel pump);
- The auxiliary cooling system.

Picture 3. Auxiliary Cooling System

In this case, heat is transferred from the reactor to the cooling water of the essential service water system, which in turn is cooled by the atmospheric air. It should be noted that:

- The high and low pressure reactor emergency cooling systems are designed for cooling the reactor at accident conditions with failure of SGs water supply system due to seismic event and other causes. During seismic event deminearalized water from the reserve tanks is supplied to the SG by the high-pressure pumps with steam damp into the atmosphere through BRU-A or PRZ SV (feed-and-bleed). During pressure drop in the SG to 5kgf/cm^2, cooling from "feed-and-bleed" regime is transferred in the closed circuit of the secondary coolant circulation. Steam from the SG enters the heat exchanger of the low pressure emergency cooling system, then is cooled by service water of the essential service water system .
- The emergency demineralized water volume is 1000m^3 (two tanks with 500m^3 each).
- The high and low pressure reactor emergency cooling systems are installed in the boron rooms and relate to the category 1 seismic stability. The systems are powered from the category 2 power supply system. Power supply is foreseen also from the auxiliary cooling system.
- The primary overpressure protection system consists of two pulse safety valves of "SEBIM" company, which allows also the reactor cooling in "feed-and-bleed" condition at lack of the primary to secondary heat removal.
- The SG auxiliary make-up system is designed to make-up the SGs at total loss of power at the plant, and also at accident conditions with failure of the SG water supply systems. The system consists of diesel pump, designed for water supply to the SGs from the demineralized water storage tanks (2 tanks with 500m^3).

In accordance with the design, the equipment and pipelines of the SGs cooling and emergency make-up systems are located in the turbine hall. Service water from the non-essential service water system is used as a cooling media for the systems. There is also a possibility to supply water from the essential service water system.

The essential service water system consists of two independent channels. The system equipment is located in the separately housed compartments (pump stations). Water from the essential service water system is cooled in the spray ponds.

Cooling water of the cooling system is taken from the supply channel (77240m^3 volume) Losses of the supply (and also discharge) channel are compensated by the pump stations ("Sevjur" and "Prud").

Water of the non-essential service water system is used as main make-up for the essential service water system channels. Water of the discharge channel (36000m^3 volume) is used for redundant make-up of the essential service water system. This volume provides with the unit operation during emergency cooling within 15 days. Besides, if needed, there is a possibility to use water from the supply channel (in this case the discharge channel is filled by gravity).

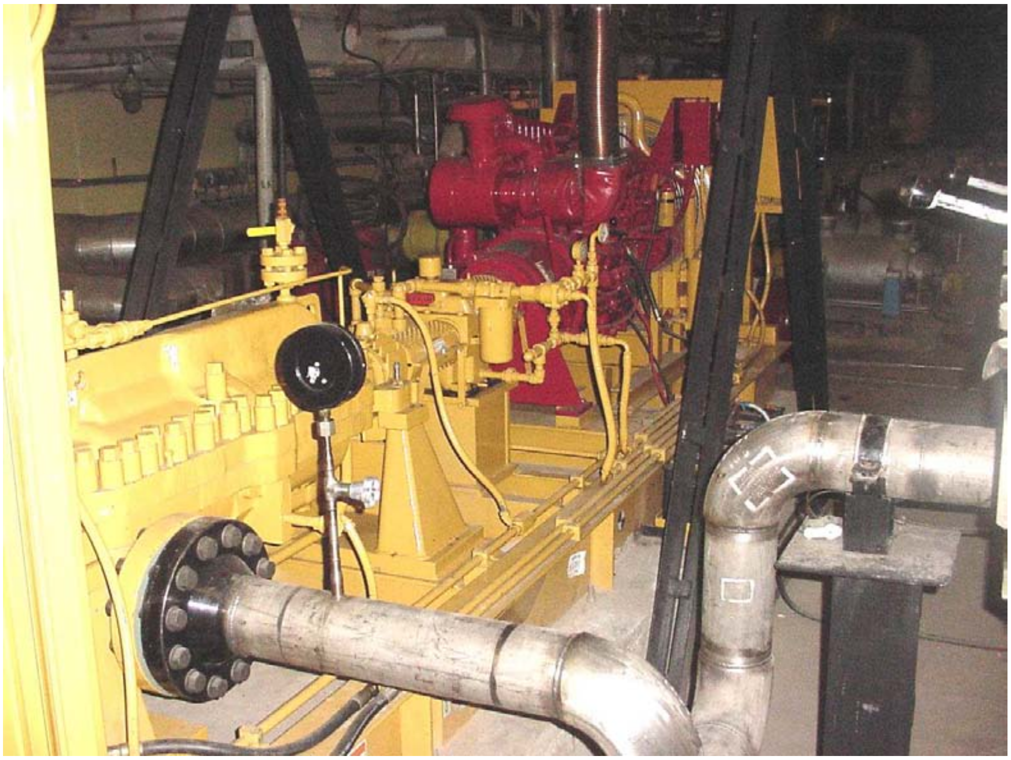
In addition to the above mentioned, the design foresees a diesel-pump station with 5 diesel pumps designed to supply water from the discharge channel to the consumers (for instance to the heat exchangers of the cooling system) and to make-up the essential service water system channels at total loss of power at the plant.

Picture 4. Diesel Pumps of Essential Service Water System

In frame of the Armenian NPP safety analysis report the core damage time period at total loss of power has been estimated. Taking into consideration failure of the SGs auxiliary make-up system, the drainage time period and the time period when unacceptable value of cladding temperature is achieved (1200°C) have been estimated. These time periods were estimated 8 and 10 hours respectively. After the accident at the Fukushima Daiichi NPPs the Armenian NPP performed additional calculations taking into consideration the SG auxiliary make-up systems operability; impact of the ultimate heat sink loss was analyzed separately. The total loss of power at the NPP assumes the loss of external and internal AC power supply (complete blackout) on buses, related to and not related to safety. It doesn't include AC loss from the accumulator supplied loads. This concerns the external power supply loss in combination with failure of DG to start-up. The analysis assumed in that NPP blackout starts after earthquake, which results in rupture of the main steam header. It was also assumed that the SG make-up diesel pump remained operable, but with the purpose to determine the time period before the core damage when the SG make-up was unavailable, it was accepted that auxiliary water was not supplied to BZOV-1,2.

The analyses have been performed for the following conditions:

- Immediately before earthquake the reactor and all auxiliary systems were operated with nominal operating parameters for pressure, temperature, flow rate and power. All NPP equipment also operated normally. Analysis with application of RELAP determined the time interval between the beginning of the earthquake and increasing the allowable value of any of the acceptance criteria or the core uncovering or interruption of the natural circulation due to the primary coolant loss. This analysis considered loss of the primary coolant and reducing of the primary coolant inventory in the SG. The time period before uncovering the SG lower row tubes is 4.87 days. The analysis results demonstrate that the acceptance criterion on the maximum cladding temperature is violated in 5 days.
- The same calculation was performed taking into account failure of the ultimate absorber, but the NPP power supply remained intact. In this case water can be supplied to the SG from the deaerators and BZOV -3,4. The time before uncovering the last lower row of the SG tubes and violation of the maximum cladding temperature criterion is 15 and 16 days respectively.



Picture 5. SG Auxliary Make-up Motor Pump

The Armenian NPP design foresees the cooling pond cooling system intended for maintaining water temperature in the cooling pond. The system consists of two pumps and a heat exchanger. The pump electric motors are powered from different sections of 0.4kV reliable power supply group II. Besides the standard power supply scheme it is also possible to power the pumps electric motors from the SG auxiliary cooling system by separately traced cables. Water from the essential service water system is supplied to the heat exchangers for cooling the cooling pond water (primary absorber).

In accident conditions with failure of the cooling pond cooling system the design allows cooling of water in different ways:

- Mixing of the cooling pond water with water of the emergency boron storage tank (with a net volume of 800m^3). Power supply of electric motor pump (2NZB) for water supply from the emergency boron water tank in the cooling pond is provided from the section 0.4 kV reliable power supply group II;
- Supply of water in the cooling pond from the emergency boron water tank of the unit №1. In this case it is possible to power the electric motor pump (1NZB) from the SG auxiliary cooling system;

- Supply of water in the cooling pond from the systems not containing boron solution, such as the pure condensate system and the fire water supply system. Lattice spacing of racks for storage of fuel assemblies eliminates the possibility of nuclear chain reaction.

There have been made calculations of the time intervals necessary to an operator in case of failure to cool the cooling pond, as well as the flow rates, that ensure cooling of spent fuel in the cooling pond cooling. Calculations were performed for the cases, when nuclear fuel is completely discharged from the core, and after the reactor core refueling.

The following conservative assumptions were accepted in the calculations:

- All energy is transferred to the cooling pond water;
- Loss of heat from the cooling pond was neglected;
- The time of complete discharging and refueling is accepted as 10 and 20 days respectively;
- Initial water level in the cooling pond at the first layer and both layers covered (the first and second) was accepted as 4.6m and 10.2m respectively;
- The reactor power before shutdown was accepted as 92% from nominal;
- Besides fuel assemblies discharged from the core during complete discharge, there are another 349 fuel assemblies in the cooling pond discharged during previous five years;
- Besides fuel assemblies discharged from the core during refueling, there was another 4/5 part of fuel assemblies in the core discharged during previous four years.

The residual heat release was estimated using [2]. During complete discharge:

- Residual power of fuel assemblies discharged from the core is 3.13 MW. The residual power of fuel assemblies discharged during previous five years is 220 KW.
- Total residual power for refueling is 619 KW.

The calculation results are provided in the Table 1.

The table 1 demonstrates that during complete core discharge and during failure of the cooling pond cooling system, water in the cooling pond starts boiling in 3.2 hours, and the fuel damage starts in 33 hours. When the cooling pond cooling system fails, cooling of fuel assemblies in the cooling pond can be provided by supply of boron solution from B-8 into the cooling pond with NBO-1,2 with discharge to B-8 boron tank through spill in the cooling pond. The pumps capacity is $90m^3/h$ and $100m^3/h$ respectively, which according to the Table 1 is sufficient to prevent water boiling in the cooling pond even at complete discharge of the core.

At total loss of power at the NPP, when the cooling pond cooling system (NBO-1,2; NBZ, etc.) fail, clean condensate with the flow rate $6.1m^3/h$ and $0.36m^3/h$ should be supplied to the cooling pond (according to subcriticality in the cooling pond is provided also during filled clean condensate as well) to prevent fuel damage in the cooling pond, for “complete discharge” and “refueling” options respectively.

The technical decision has been made to develop a project on installation of a dry pipeline from the reactor hall transport corridor to the cooling pond aimed to supply water from the fire trucks to the cooling pond. The fire protection service has fire trucks AC-5-40 type (water capacity 5t, flow rate 40 l/s). In 30 hours after failure to cool fuel assemblies in the cooling pond, fuel damage can be prevented and the level in the cooling pond can be maintained if water is supplied from one fire truck each 49 minute. To prevent the exposure rate increase in the central hall of the reactor building (before the water thickness over the fuel is reduced to 2.0m) the water supply to the cooling pond is envisaged to arrange in 20 hours after failure of fuel assemblies cooling in the cooling pond. Installation of a water supply pipeline from the pressure head pipe of the SG make-up drainage pump to the cooling pond is also considered.

Table 1: Calculation results

Operation Condition	Complete discharge	Fuel is located only in the lower layer of the cooling pond
Time when the temperature of boron solution in the cooling pond is heated by 1^{o}C	5.3 min	34.8 min
Time before boiling of boron solution in the cooling pond	3.2 hours	21.3 hours

Time when 1m boron solution evaporates from assembly and container compartments of the cooling pond	5.0 hours	
Time when 1m boron solution evaporates from assembly compartment of the cooling pond	3.2 hours	17,1 hours
Time before the water level reaches the top of fuel assemblies	26.7 hours	70.1 hours
Time before the water level reaches the top of fuel elements	27.7 hours	75.7 hours
Start of fuel damage (fast oxidation of cladding along with hydrogen generation)	33.0 hours	104.6 hours

The time periods to ensure DC and AC of category I power supply after total loss of power at the NPP were assessed. Calculations performed for 2BSHPT-1 and 2BSHPT-2. The time periods to ensure DC and AC power supply from 2BSHPT-1 were assessed before and after switching AMNU from 2 BSHPT -1 to BSHPT.

Two options were considered:

- All consumers of 28NA and 29NA busbars powered from both busbars, are powered from one busbar;
- Loads of 28NA and 29NA busbars are equally distributed.

The calculation results are provided in the Table 2.

Table 2 demonstrates that after switching the power supply of AMNU from BSHPT-1 to OSHPT, 2BSHPT-1 operation time increases by 0.6 hours and is 6 hours. But if loads distribution is performed, 2 BSHPT -1 operation time may be increased to 8 hours. In this case, 2 BSHPT -2 would remain operational more than 8 hours.

Table 2: Calculations Results

Operation Condition	Option 1	Option 2
Operation Duration of 2BSHPT with AMNU	5.4 hours	7.5 hours
Operation Duration of 2 BSHPT without AMNU	6.0 hours	7.8 hours
Operation Duration of 2 BSHPT with AMNU	8.8 hours	12.9 hours

Power supply of AMNU from BSHPT-1 has already been transferred to the direct current plant board. The decision has been made to use the DG with 200KW capacity (used for physical protection needs) to recharge accumulator batteries. One of DG-s with 1.6 MW capacity is foreseen to operate for the additional emergency power supply system, and cooling water supply to the DG is envisaged to be ensured from the discharge channel by the diesel pumps.

It has been demonstrated that service water in the spray ponds of the essential service water system with minimum level is sufficient for cooling the essential consumers of each channel within 72 hours for all types of accidents.

In accordance with the RA Government Decree on re-start of the Armenian NPP Unit №2 and the ANRA's requirements, measures on seismic hazard evaluation of the Armenian NPP site were implemented in the period 1993-1995 by the Armenian organizations and specialists and foreign organizations with the IAEA support. The following results were obtained that had been the approved by the IAEA experts:

- 0.21g PGA for 50% confidence and 0.34g PGA for 84% confidence are expected at the Armenian NPP site;
- Probability of volcanic hazard within the Armenian NPP area is extremely low and recovery of volcanic activity in the near future is not expected.

Before the Armenian NPP Unit №2 re-start the seismic stability of systems structures and components on the point 0.21g (50% confidence) had been verified.

After the Armenian NPP Unit №2 re-start the RA Government adopted decree on the Unit №2 safety improvement in frame of which the seismic safety reevaluation was considered as the priority task. As far as all existing regulations concerned the new designed NPPs, the IAEA experts developed the Technical Guidelines for the Seismic Re-evaluation Programme of the Metsamor NPP - Unit № 2, where the factor 0.35g (84% confidence) is accepted as a new reviewed level earthquake. The technical guideline established 10 main tasks:

Task 1: Review Level Earthquake;

Task 2: Geotechnical Data;

Task 3: As-built Design Data Collection

Task 4: Function/Systems Component Classification

Task 5: Soil-Structure Response;

Task 6: Soil Capacity Evaluation;

Task 7: Structure Capacity Evaluation;

Task 8: Distribution Systems Walkdown and Evaluation

Task 9: Equipment Walkdown;

Task 10: Further Analysis Upgrades Design, Implementation.

All 10 tasks have been implemented.

In the period 1995-2011 the Armenian NPP accepted more than 20 IAEA expert missions that reviewed the scopes and results of the implemented measures.

During implementation of the safety upgrading program for 1998-2004 the seismic stability of PRZ safety valves and SG, fast acting valves, reverse DG was ensured with application of conservative response spectra of relevant period (at PGA 0.35g).

The new SG auxiliary emergency make-up system from the demineralized water tank with the summary capacity 1000m^3 was implemented in 2004. The system contains the diesel pump located in the seismic area that allows supplying water to the SGs during total loss of power at the NPP.

In 2005 during upgrading the neutron flux control system and the DG sequential start-up automatics, the seismic stability was provided to the RLE through testing by relevant response spectra. In the period 2010-2011 new systems to control DG emergency power supply and neutron flux were implemented at the Armenian NPP; the seismic stability of the new systems was provided with application of conservative response spectra of the relevant period (at PGA 0.35g).

The analysis of bearing capacity of the Armenian NPP main building, redundant DG station (emergency power supply system) and the venting stack at the RLE with 84% confidence (0.35g) was performed in 2007.

For analysis of the main building there were selected nodes and elements with the maximum seismic stress that were obtained as a result of special processing of two separate calculations' results - seismic, with account taken to the dynamic soil-structure interaction (SuperSASSI calculation model, 3- component spatial reaction) and static (Stardyne calculation model). In frame of these calculations there was also verified the concrete wall of the reactor hall above +10.5 level, as a relatively weak in comparison with the reinforced concrete structures of the confinement, the safety margin of which was twice higher than at the RLE.

In justifying the seismic stability of the reinforced concrete columns and steel structures of the redundant diesel generator station (emergency power supply system) against the RLE there were considered various sections of columns, roof trusses elements, metal structures and nodes of their intersections. Following the recommendation made by the IAEA experts in 2007 during the seismic walkdown the interaction of structures of the turbine hall with an auxiliary building (longitudinal shelves) as well as testing the internal wall panels of the redundant diesel generator station (emergency power supply system) to its net weight have been considered in frame of seismic qualification under the ARM/9/022 TC project. In accordance with the analysis of interaction of the turbine hall structures and the longitudinal shelves, the beams have a large safety margin for the RLE (0.48 g). Besides there were conducted tests of internal wall panels of the redundant diesel generator station (emergency power supply system) for the adequacy of the load in 1.0 g (net weight), and in accordance with the analysis the panels have double safety margin. The venting stack was assessed against the RLE to account for its interaction with the main building. A conservative approach was applied in the design of venting stack (category 1 seismic stability), and despite the fact that PGA 1g was built-in in the design, calculations, performed with application of modern methods have demonstrated that it fully meets the RLE requirements (0.35 g) and has a large safety margin.

The essential service water system and the spray ponds being new structures are designed with respect to blast loads and have large seismic stability margin – low probability failure with large confidence 0.64g.

The calculation of bearing capacity of the boron room was performed in 2011 (premise of safety systems), according to which the boron room has a large seismic stability margin - low probability failure with large confidence 0.98g.

Taking into account the above mentioned it can be stated that all buildings and constructions that should retain their integrity at bringing the reactor facility in safe condition during seismic event are adequate to the RLE (PGA 0.35g).

In 2006 the IAEA experts have been approved the floor response spectra for the main building and the redundant diesel generator station (emergency power supply system). In accordance with "Terms of Reference for a detailed seismic walkdown of the Armenian NPP Unit №2," the company CKTI "Vibroseysm" and “Stevenson and Associated” Czech Company, completed the final seismic walkdown during the annual scheduled outage in 2007. All 2589 systems, structures and components included in the safe shutdown equipment list had been considered and documented. 23 components were not available for the walkdown (they are currently qualified as a part of the seismic evaluation in frame of the IAEA ARM/9/022 project), 655 were considered as parts of other elements, 1193 were seismically qualified by the GIP (Generic Implementation Procedure for VVER-type nuclear power plant for verification of seismic adequacy) method and were excluded from further considerations. The other equipment, requiring implementation of additional measures with respect to the identified deficiencies have been characterized by the degree of complexity, namely: 446 SSC described as «easy fix», easily-implemented reinforcements (qualification 2), 29 systems (components) that require development of design solutions (Qualification 3), 26 components that require calculations or tests, or, if necessary, upgrading (Qualification 4).

The seismic resistance of the main circulation piping and the primary PRZ against the RLE adequacy was estimated by calculations according to which the PRZ surge line did not meet the RLE requirements, so it was recommended to install dampers. The recommendation has been fulfilled: three dampers are already installed.

The analysis of the control rods of the reactor control system and the temperature sensor of the main circulation loop of the primary circuit, which confirmed their seismic stability, have been performed.

The analysis of the seismic stability of high-energy pipes of the secondary circuit on the level of 14.7 meters has been completed; the design solutions to strengthen the pipelines (mounting hydraulic shock absorbers, arresters, supports) have been developed. Implementation of these measures is scheduled for 2012.

The analysis of the seismic stability of 11 systems, that did not meet the RLE requirements, have been completed. There have been obtained the calculation justifications, according to which dampers, additional supports and hangers should be installed, and the existing supports and hangers should be reconstructed (replaced). Implementation of these measures is scheduled for 2012.

The calculation of the boundary seismic stability of the demineralized water tank (emergency make-up system of SG) with regard to the measures undertaken to improve the strength, which resulted in a project aimed to strengthen them. At present the strengthening measures are implemented and completion is scheduled in 2012.

Based on the results (preliminary and final) of the seismic walkdown in the period 2000 - 2007 vulnerabilities available in the cable tracing have been reinforced through installation of additional vertical columns and horizontal restraints. In frame of the final walkdown there was performed calculation of the most loaded sections of cable lines, which confirmed the adequacy of the cable lines to the RLE. Ceilings of the control room and the reactor control system board have been upgraded (with respect to the RLE) as a result of the seismic walkdown. All identified deficiencies (upper fixing, enhancing racks, fixing of cabinets among each other, fixing of doors, adding bolts, etc.) in cabinets, assemblies and panels have been completely eliminated. All above mentioned reinforcements relate also to cabinets, panels and assemblies of fire protection, radiation control and emergency communication systems. As a result, it can be stated that all electrical equipment included in the safe shutdown list is adequate to the RLE.

The sensitivity analyses performed in frame of the PSA have demonstrated the following:

1. If it is proved that make up gravity tank is not needed (i.e. DG can successfully be started-up and operated at the initial period without it) then seismic CDF will be decreased by 25%;
2. Installation of 3 new snubbers on the pressurizer surge line decreases core damage frequency caused by seismic event by 2%;
3. Improvement of fragility of the Unit № 1 demineralized water tank will decrease core damage frequency caused by seismic event by 6%;
4. As a result of the SG make-up system upgrading the core damage frequency caused by seismic event was decreased by 9%.

The first, second and the forth activities have already been completed and the third one is in process of implementation. In connection with change of the PSA main model, the PSA level 1 for external effects and the seismic PSA should be updated.

Following the accident at the Fukushima Daichii NPP the ANRA has made the following requirements:

- To perform "stress-test" at the Armenian NPP Unit №2 in accordance with the WENRA/ENSREG technical specifications;
- To perform re-evaluation of the seismic stability of the confinement and identify the factual state of the building structures of the categories 1 and 2;
- To develop the safety upgrading program of the Armenian NPP Unit №2 with regard to seismic safety issues and "stress-test" results.

Implementation of the above mentioned measures envisages revision of the SAR for the Armenian NPP Unit № 2.

3. SEVERE ACCIDENT MANAGEMENT AND RECOVERY (ON-SITE)

The Armenian NPP guidelines on severe accidents management were developed based on the approach specified in the IAEA NS-G-2.15 "Severe Accident Management Programmes for Nuclear Power Plants".

The severe accident management (SAM) includes protection and mitigations areas being the SAM goal and objective.

As implementing the symptom-oriented emergency procedures it is planned to improve the Armenian NPP emergency documentation system (it is planned to develop and interconnect procedures on deviations, symptom-oriented emergency procedures on violation of normal operation at the Armenian NPP, symptom-oriented emergency procedures for the shutdown reactor, instructions on mitigation of deficiencies in the cooling pond).

The symptom-oriented emergency procedures are intended to be applied at violation of normal operation of the Armenian NPP and at design accidents in the reactor facility resulting in activation of the reactor protection system, as well as at beyond design accidents before the core is damaged.

The protection area includes prevention of significant core damage. The protection area strategy is aimed at retaining the safety functions important for the core protection (they are often referred to as the critical safety functions). These functions are:

- Transfer of the reactor to subcritical condition and maintaining the reactor in that condition;
- Fuel cooling; and

- Confinement of radioactive materials against release into environment.

The mitigation area is a derivative from such activities as:

- Filling (secondary circuit make-up) for protection of SG tubes against break caused by metal creep;
- Primary pressure decrease to prevent the reactor vessel damage and thermal effect on the confinement;
- Filling of the reactor shaft to prevent or slow down the reactor vessel damage and further damages of the reactor vessel and concrete of the shaft;
- Hydrogen concentration relaxation; and
- Confinement pressure decrease to prevent its damage.

The strategy in mitigation area allows to:

- Limit progress in the core damage as soon as it is initiated;
- Maintain the confinement integrity as long as possible;
- Minimize release of radioactive materials;
- Achieve long-term steady state.

Based on the developed strategies on severe accidents management and taken measures the Armenian NPP plans to revise the Severe Accident Management Guideline (SAMG). The following is scheduled to be implemented during revision of the Severe Accident Management Guideline:

- Analysis of potential severe accidents;
- Selection, adaptation and development of new strategies for severe accidents management (about 30 strategies);
- Identification of parameters' setpoints for situation diagnostics along with their justification (over 50 set points);
- Identification and specification of a set of instruments to be used at severe accident;
- Implementation of all required analytical support calculations for severe accident sequences without/with modeling of operator actions, applied for development, specification and validation of strategies and guidelines.

In particular, drafts of two guidelines on severe accidents management at MCR were developed:

- **Guideline on initial actions at MCR in case of severe accident**

The Guideline describes the MCR personnel actions before the Technical Support Group (TSG) starts its work, implementation of required actions, parameter control.

- **Guideline on actions at MCR after TSG starts its work**

The Guideline describes the MCR personnel actions after the TSG starts its work, establishment of contact with the TSG, submission of initial and current information and implementation of required actions.

These guidelines specify the MCR personnel actions during transfer from the emergency operating procedures to the severe accident management procedures.

“Diagnostic Flow-Chart (DFC) for TSG” is developed. It is intended guide the TSG activities on accident mitigation and transfer of NPP in steady state.

The DFC is the main tool used by the TSG for diagnostics/evaluation of the NPP condition and identification of the guidelines to be followed at severe accidents management in a particular situation.

The SAMGs are developed based on the DFC. These guidelines are aimed at description and evaluation of a strategy, which could be applied for mitigation of problems identified in the DFC. In particular development of separate guidelines is envisaged with description of actions intended for:

- Water supply to SGs;
- Primary pressure decrease;
- Water supply to the primary circuit;
- Water supply to the confinement;
- Decrease of fission products release;
- Management of situation in the confinement;
- Decrease of hydrogen concentration in the confinement;
- Flooding of the confinement.

“Serious threat tree” (STT) is also being developed. The STT identifies serious threats to the confinement integrity as a barrier on the way to fission products release. The STT monitoring provides with control over indicators of fission products release into the environment, or of serious threat to the confinement integrity which could result in significant fission products release. The STT is a basis for guidelines that contain strategies on:

- Water supply to the primary circuit for the core recovery;
- Flow required to remove residual heat;
- Assessment of potential hydrogen ignition;
- Velocity of volumetric release from the ventilation stack;
- Water level and volume in the confinement;
- Gravity flow drain from the borated water storage tank;
- Hydrogen impact on pressure decrease in the confinement.

The accident management actions shall be evaluated with regard to their simplicity in application. During severe accidents the stress level of operator and experts is high. Thus, while decreasing potential human error, a simplicity of actions increases general success of accident management. For that, graphic calculation tools (GCT) are being developed. They can be used in accident management. These auxiliary tools are developed based on calculations and they are presented, as a rule, in graphic way (graphs, diagrams, nomograms, tables, etc.).

Four Guidelines on Serious Threats management are being developed. These guidelines are developed based on the STT and contain recommendations to be immediately implemented to mitigate serious problems, identified in the STT:

- Mitigate fission products release;
- Decrease pressure in the hermetic compartments;
- Control hydrogen ignition in the confinement;
- Control vacuum in the confinement.

Currently two guidelines for transfer from the SAMG are developed. These guidelines identify long-term strategies, control of transfer to steady state and procedures of transfer from SAMG, namely:

- **Actions of long-term control**

The guideline allows controlling parameters specifying NPP condition in severe accidents, which are related to long-term problems of strategy applications. Each of strategies has specific requirements to potential implementation in long-term period. For instance, there could be a need to fill with water the tanks used for SGs make-up, etc. Thus, it is required to control parameters related to long-term operation of the safety equipment and systems.

- **Transfer from SAMG**

The guideline describes the procedure of transfer from the SAMG based on transition of the NPP to steady state. The TSG is provided with recommendations, methodology for development of a set of limits and preventive measures based on consideration of large amount of fission products release from the core and other important aspects of severe accident sequence.

During the annual scheduled outage in 2011 the VUEZ, a.s. (Slovak Republic) specialists experienced in strengthening the Bohunice NPP V1 confinement, were involved in conduct of integral test on the confinement. The technical decision on strengthening the confinement tightness is developed. The scope of works will cover:

1. Preparatory measures;
2. Design measures
3. Strengthening tightness of the confinement elements.

4. NATIONAL ORGANIZATIONS

To achieve and maintain a high level of safety in the siting, design, construction, commissioning, operation and decommissioning of nuclear facilities the Republic of Armenia established a governmental infrastructure consisting of state authorities and entities with well defined responsibilities and functions. The Republic of Armenia did not make changes in the national governmental infrastructure after accident at the Fukushima Daichii NPP.

The state regulation of nuclear and radiation safety in the atomic energy utilization field in the RA is implemented by the Armenian Nuclear Regulatory Authority in accordance with the Article 16,17,17.1 of the Law of the RA on Safe Utilization of Atomic Energy for Peaceful Purposes and the Statute, approved by the RA Government.

In accordance with the Article 19, paragraph 2 of the Law of the RA on Safe Utilization of Atomic Energy for Peaceful Purposes and the Statute (point 1.2.1.6) of the Armenian NPP the prime responsibility for safe operation rests with the operating organization.

“Armenian NPP” CJS is a state-owned company and the shareholder is the Ministry of Energy and Natural Resources of the RA that functions in accordance with the Laws of the RA on Joint-Stock Companies and on Safe Utilization of Atomic Energy for Peaceful Purposes, as well as in accordance with its statute.

The relations on population protection in case of emergencies are clearly settled down in the RA Government Decree № 2328-N adopted on 22 December 2005 on approval of the Population Protection Plan in Case of Nuclear and/or Radiation Emergencies at the Armenian NPP (Off-site Plan) which specifies jurisdictions of each national organization. There is a transparent direct communication among the ministries and the regulatory authority, as the state authorities, the statutes of which are approved by the RA Government; the aforementioned state authorities report to the RA Government.

Certain functions related to population protection and response to nuclear and radiation emergencies are assigned to the Rescue Service of the Ministry of Emergency Situations of the RA.

There are also internal technical support organizations in Armenia, in particular:

- Nuclear and Radiation Safety Center (ANRA Technical Support Organization);
- “Armatom” CJS (ANPP Technical Support Organization) and other.

To ensure effectiveness of the decision making process during emergency situations the Armenian NPP plans to be involved in the Regional Crisis Centre (RCC) and get technical assistance from technical support centres of "Rosenergoatom" Concern of the Russian Federation.

5. EMERGENCY PREPAREDNESS AND RESPONSE, POST-ACCIDENT MANAGEMENT (OFF-SITE)

"The national plan of population protection in case of nuclear and/or radiological emergencies at the Armenian NPP", had been adopted under the RA Government Decree № 2328-N on 22 December 2005, which was amended in 2008 and 2010 under the relevant RA Government Decrees.

To fulfill the requirements established in the Decree, i.e. Annex 1 paragraph 5, points 17, 18, 21 and 23, the following legal acts had been developed:

- Radiological monitoring organization plan in case of nuclear and/or radiological emergencies at the Armenian NPP;
- Fire protection plan in case of nuclear and/or radiological accidents at the Armenian NPP", approved by the Order N 128-A of the Minister for Emergency Situations RA on December 9, 2010;
- The Armenian NPP emergency plan of the RA Armavir region emergency commission;
- The Armenian NPP emergency plan of the RA Aragatsotn region emergency commission;
- Evacuation plan of the RA Armavir region emergency commission;
- Evacuation plan of the RA Aragatsotn region emergency commission;
- Evacuation plan of the RA Kotayk region emergency commission;
- Evacuation plan of the RA Shirak region emergency commission.

These documents have been agreed with the MES RA and approved by the relevant governors.

The plans include the response organization and implementation, forces and resources as well as population protection measures.

The relevance of the plans has been checked up through regular training and exercises.

The Armenian NPP emergency response forces involve:

- MES RA: 15 monitoring groups 3 persons in each, 8 fire fighting detachments;
- RA Police: 233 groups with 1383 persons to ensure the public order;
- RA Ministry of Health: 87 ambulances with 261 medical personnel to provide with medical care;
- Required transportation means: 871 vehicles and 30 coaches.

95771 people need to be protected in case of an emergency at the Armenian NPP.

The improvement of the emergency planning and response system is of great importance in order to ensure comprehensive and adequate functioning of the Emergency Response System of the Armenian NPP. One of the methods of improvement is organization of emergency response drills and exercises.

Scenarios and programs of conducting drills and exercises are developed on the basis of reports "Review of Beyond-the-Design-Basis Accidents for WWER Reactors" by OKB "Gidropress" and on the basis of reports "Assessment of Radiation Consequences of Beyond-the Design-Basis Accidents for the Armenian NPP Unit № 2" by Kurchatov Institute. In compliance with the schedule, all the members of the Armenian NPP Unit № 2 Emergency Response System personnel take part in exercises and drills.

The guideline "Classification of Emergency Situation at the Armenian NPP" is structured in such a way that the assessment procedure was simple but efficient, which would enable the coordinator of emergency actions still at an early stage of an accident makes timely and appropriate decision on personnel and public protection and on implementation of mitigation measures.

The drills and exercises are aimed at:

- Working out skills on undertaking actions during accidents at the Armenian NPP with radioactive materials release;
- Working out skills of interaction between the Armenian NPP and other authorities and organizations involved in emergency responce;
- Personnel training to use means of warning, preventing undesirable progression of accident and limitation of its consequences, as well as on emergency rescuing and other urgent activities;
- Personnel training to apply on rules of conduct, main protection means and actions in emergency situations, techniques of providing first medical aid, rules on application of individual and collective protection means, fire-fighting means etc.;
- Ensuring organization of public evacuation;
- Checking personnel’s preparedness to perform independent, prompt and adequate actions;

- Developing skills of management of ERS team, local authorities and entities to handle forces and means included into the Emergency Situations Prevention and Mitigation System;
- Improvement of practical skills of management of ERS team, local authorities and entities, as well as of chairmen of the committees on emergency situations in organization and undertaking actions, prevention and mitigation of consequences;
- Practical training on sequence of activities to be performed during emergency - rescue and other urgent activities to be undertaken by the personnel of ERS units.

In 2011 at the The Armenian NPPsite an exercise was conducted on long-term loss of power at ANPP site aimed at acquiring and consolidating skills related to severe accident management. It is planned to expand the scope of drills and exercises on emergency response for the Armenian NPP ERS personnel.

In particular, for 2013 it is planned to conduct a comprehensive emergency exercise with national organizations (Armenian NPP, Rescue Service, ANRA, Ministry of Public Health, Ministry of Agriculture etc.) involved in emergency response to nuclear and/or radiological accidents at the Armenian NPP.

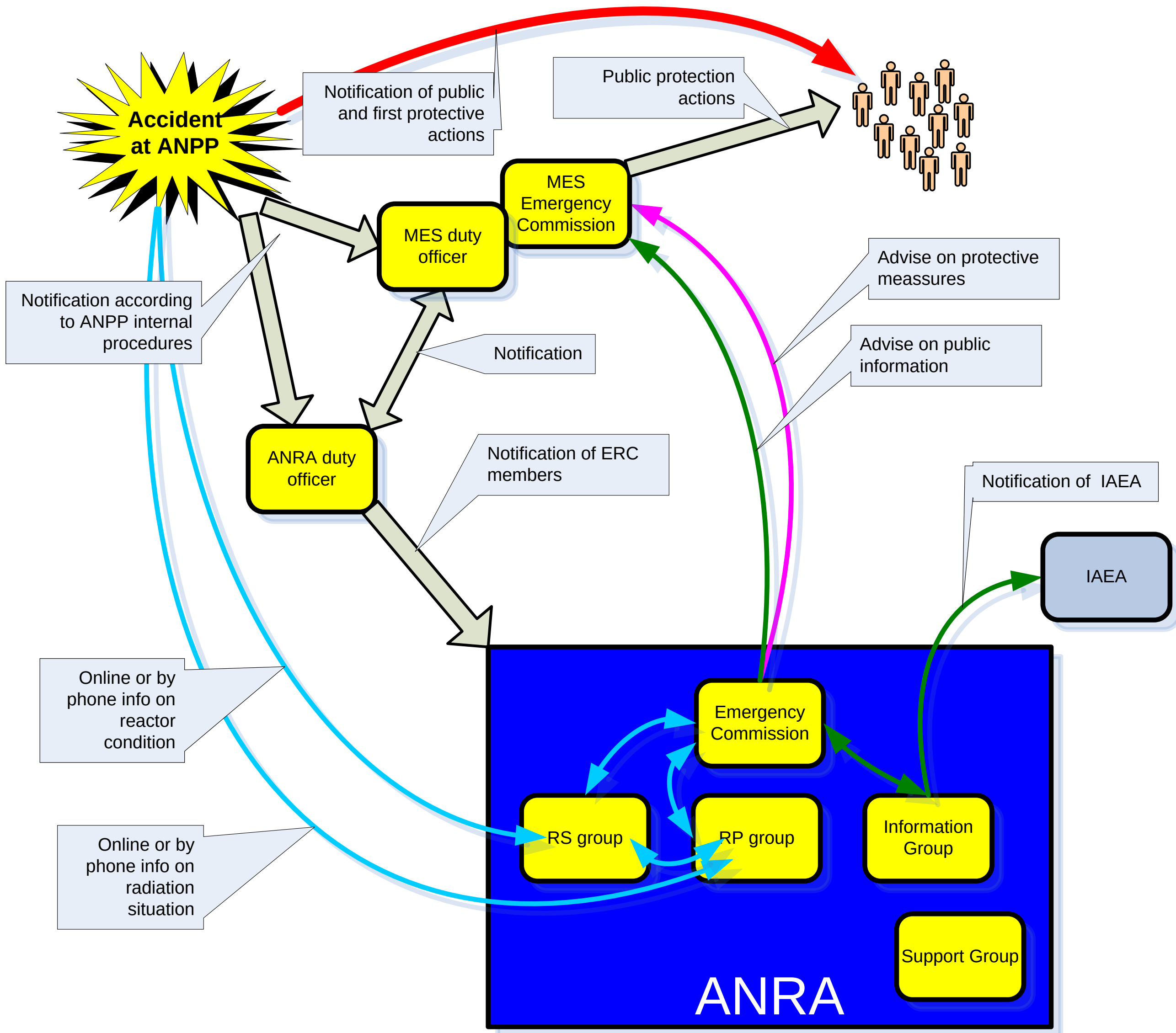
It is planned to conduct drills on the following topics:

- Earthquakes, primary circuit emergency make-up system failure;
- Failure to make-up the secondary circuit due to external event;
- Loss of ultimate heat sink.

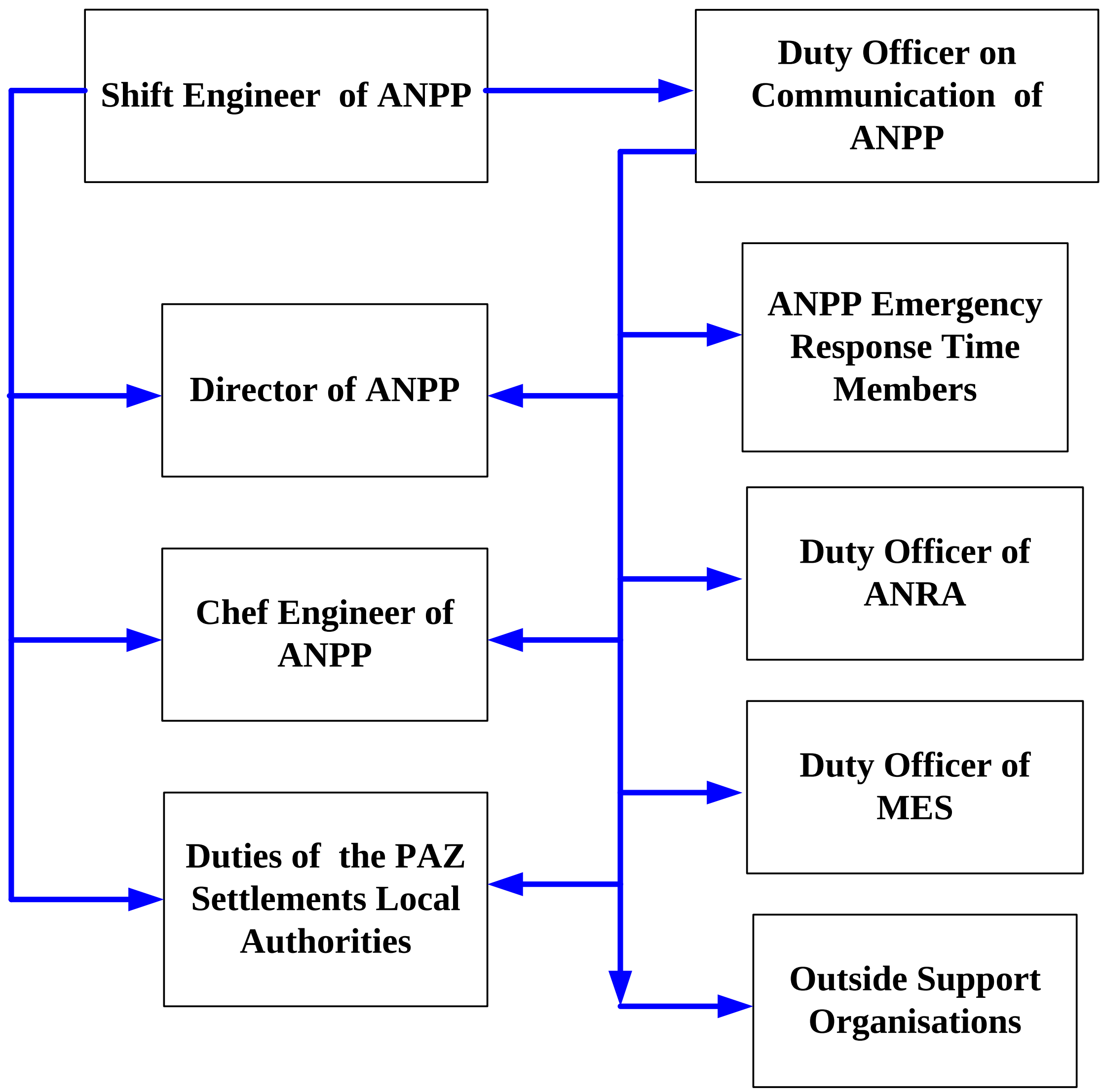
Implementation of the Permanent Radiation Control System at workplaces in MCR-2, reactor control panel, Crisis Center, Shelters 1, 3 will enable to promptly evaluate the radiological situation at workplaces for urgent protective measures to be taken by emergency rescuing teams.

Improvement of the Radiological Situation Automatic Control System (increasing the number of detectors measuring radiological situation around the Armenian NPP) enables the persons in charge to make timely decisions and implement urgent protective measures to protect the public.

Currently, 12 detectors for radiological situation measurement are installed at the Armenian NPP site and around it. By 2016 it is planned to increase the number of the detectors to 33 which will enable to include all the resided settlements within a 10 km area into the controlled area.



Picture 6. National Emergency Notification Flow-Chart



Picture 7. ANPP Flow-Chart on Nuclear and Radiological Emergency Notification (Initial Notification)

6. INTERNATIONAL COOPERATION

International cooperation and collaboration play important role in enhancing safety and regulation.

The Fukushima accident committed the Republic of Armenia to work the international community to share information and revise the national arrangements with the purpose to identify potential further improvements to comply with the fundamental principle of the continuous improvement of nuclear safety.

During the Ministerial Conference on Nuclear Safety in 2011 the Republic of Armenia made a firm commitment to apply the IAEA Safety Standards in its national arrangements for ensuring nuclear safety in a transparent and open way.

Thus, the Article 2 of the Law of the RA on Safe Utilization of Atomic Energy for Peaceful Purposes states that:

"The Government and state authorities of the Republic of Armenia within the Normative legal regulation process implemented in atomic energy utilization field in accordance with this Law shall:

- When developing and adopting legal acts related to atomic energy utilization field ensure their compliance with requirements of international treaties of the RA and safety standards of the International Atomic Energy Agency (hereinafter referred to as the IAEA);
- recognize and apply the IAEA safety standards with the purpose to bring the safety level of atomic energy utilization field in compliance with the international criteria;
- in the established order apply certificates issued by regulatory and competent authorities in atomic energy utilization field of foreign countries."

Besides on 04.06 2003 there was ratified "Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the International Atomic Energy Agency to the Government of the Republic of Armenia. The article 2 "Safety Standards and Measures" of the mentioned agreements stipulates that the Government shall apply to the operation making use of the technical assistance provide to it pursuant to this Agreement the Agency's Safety Standards and Measures defined in INFCIRC/18/Rev.1 and the applicable standards as they are established in accordance with that document and as they may be revised from time to time.

The Republic of Armenia performs systematic, regular international peer reviews of the IAEA for regulatory effectiveness, design safety, seismic safety, operational safety and emergency preparedness and their follow-ups to review the implementation of previous recommendations. In particular the following expert and review missions were accepted by the Republic of Armenia:

IPSART Mission, 2007

In October 2007 the IAEA IPSART mission was conducted at the The Armenian NPPto review the PSA results. The current PSA activities are aimed to resolve comments made during expertise process. As a result of the revising the PSA model will be brought in compliance with the state of the art for the end of 2009, i.e. upgrades to the systems. Updated data of the database on equipment failure are taken into consideration. The PSA review with the US ANL specialists will be completed at the end of 2010.

The IAEA Mission on Verification of NPP Plant Self-Assessment Program, 2007

The IAEA mission on verification of NPP self-assessment program was conducted at the Armenian NPP in November 2007. The main objective of the mission was to analyze the self-assessment program and identify the areas for improvement. The main recommendations of the mission related to the areas of improvement covered the improvement of the whole strategy for prioritization and integration of improvement program, improvement of targeted self-assessment practice and feedback of self-assessment results. Two good practices were identified by the mission: indicators of the safety management system and the methods used for assessment of the safety management system. The self-assessment practice was improved based on the mission recommendations. At present measures are undertaken to incorporate the process oriented approach in the safety management system in frame of the IAEA ARM/9/021 project.

IAEA Design Safety Review Follow-up Mission, 2009

The IAEA Design Safety Review Mission follow-up was conducted at the Armenian NPP in November 2009. The first mission was organized in 2003 aimed to review the implementation of recommendations specified in TECDOC 640 Ranking of Safety Issues for WWER-440 Model 230 Nuclear Power Plants. The review covered 45 safety issues. Based on the mission results 12 issues have been recognized resolved, including:

- Equipment classification;

- Operation control;
- I&C and electrical equipment classification;
- Application of leak before break concept;
- Pressure discharge system of primary circuit;
- Separation between high and low pressure systems;
- Core control and design
- Emergency alarming.

The other 33 safety issues have the resolution degree 3, i.e. the corrective actions to resolve issues are on the stage of completion, but the issues are not completely resolved. Based on the mission results the average degree of safety issues resolution is 3,46 (by 4 categories of ranking) confirming that design deficiencies are close to resolution. In particular it is planned to implement 8 measures for 2010 and for 2011 – 7 measures. It is expected that all safety deficiencies will be completely eliminated in the next years.

Mission on Assessment of Seismic Safety Re-Evaluation Program of the Armenian NPP Unit №2, 2009

The IAEA mission on verification of the Armenian NPP self-assessment program was conducted in November 2009. The seismic reevaluation of the Armenian NPP Unit №2 is implemented in accordance the Technical Guidelines Programme for the Seismic Re-evaluation of the Armenian NPP Unit №2 developed with the IAEA assistance in 1997.

Pre-OSART Mission in 2010

In April 2010 the Pre-OSART mission was organized. The objective was to introduce to the Armenian NPP personnel the methodology of verification of operational safety, examples of wakdowns and self-assessment, discussion and agreement of organization and technical issues concerned with the OSART mission planned for May 2011.As a result the The Armenian NPPobtained a set of international safety standards and practical skills on conduct of self-assessments and detection of departures from the international safety standards. Working groups for all 8 areas of assessment are composed at the Armenian NPP. At present measures on detection of departures and their elimination are in process.

Besides in frame of the EC ARTS06 project joint inspections were conducted by the ANRA and EC experts based on the OSART guideline addressing the issues which will be examined during the OSART mission, in particular operational safety, safety management and quality assurance, inspection of maintenance, technical support, operations management, The Armenian NPPpersonnel qualification and training as well as the on-site emergency plan and preparedness. The recommendations on areas of improvement have been made to assist with preparation to the OSART mission.

OSART Mission in 2011

Under the leadership of the IAEA's Division of Nuclear Installation Safety, the OSART team performed an operational safety review of the Armenian NPP from 16 May to 2 June 2011. The OSART team at the Armenian NPP conducted an in-depth review of the aspects essential to the safe operation of the plant. The conclusions of the review were based on the IAEA's Safety Standards and proven good international practices. The OSART team has made recommendations and suggestions related to areas where operational safety of the ANPP could be improved and also has identified good plant practices which will be shared with the rest of the nuclear industry for consideration of their application.

The Republic of Armenia invited the IAEA EPREV mission. At present the relevant arrangements and preparations jointly with the concerned state authorities are made to conduct the EPREV mission from 15 to 25 October 2012 in Yerevan. The Republic of Armenia also scheduled to host the IRRS mission in Quarter 4 2013. The following expert and review missions have been accepted by the Republic of Armenia.

The Fukushima accident necessitated to make thorough and transparent safety assessments of the Armenian NPP. The decision was made that the ANPP behavior should be reassessed on the basis of comprehensive safety assessments ('stress tests') following the WENRA proposed technical specification. The Armenian NPP jointly with EU experts should conduct studies which are to be submitted to the ANRA for review in September 2012. After review the ANRA will prepare the national report and submit the EU at end of this year. During review of the stress-test results the ANRA plans to interact with the international organizations and the regulatory authorities of different countries in frame of the technical cooperation projects of the IAEA, EU and the cooperation agreements.

Besides, to exchange safety related information, the ANRA has established cooperation agreements with the US NRC, the Russian Federation, and Ukraine. In the framework of IAEA TC projects and the INSC program, the ANRA cooperates with the regulatory authorities and technical support organizations of the Russian Federation, Ukraine, Finland, the Czech Republic, Bulgaria, Lithuania, Belgium, France, the Slovak Republic and other countries. The ANRA is a member of the VVER Forum that joins nuclear regulatory authorities of countries operating VVER NPPs, and an observer to WENRA. The ANRA also cooperates with the US DOE in the frame of the International INSEP.

The Government of Armenia gives the highest priority to nuclear and radiation safety along with nuclear security. The establishment of the Nuclear Energy Safety Council that reports directly to the President of Armenia and is composed of recognized world authorities in nuclear science and engineering, gives evidence of the priority assigned by the Government to nuclear energy matters and to nuclear safety in particular. Each one and half year the Council convenes to review the progress made and activities performed by the regulator and operator, to assess and make recommendations on further improvements.

In 2005, the IAEA initiated the establishment of an international coordination mechanism – the Technical Meeting for Coordination of Assistance to the Armenian NPP, with the participation of donor countries (EU, USA, Czech Republic, Russian Federation and UK). During the first meeting in December 2005, an international nuclear safety upgrading plan was established which was updated in October 2006, May 2010. The last meeting aimed to review the safety upgrading measures that have been implemented for the ANPP since the last meeting and to update the exiting plan was held in October 2011.

The Republic of Armenia reviewed and commented the proposals on amendments to the Convention on Early Notification of a Nuclear Accident, Convention on Nuclear Safety.

In accordance with "Convention on Assistance in Case of Nuclear or Radiological Situation" – IAEA 26.09.1986 and "Safety Standards Series: Preparedness and Response in Case of Nuclear and Radiological Accident, GS-R-2", arrangements for establishing a Regional Crisis Center (RCC) for NPPs with WWER reactor type on the basis of "Rosenergoatom Concern" OJSC Crisis Center are currently in place.

Cooperation with the IAEA

The Republic of Armenia joined the Treaty on the Non-Proliferation of Nuclear Weapons on 24 September 1991 and has been an IAEA Member State since 1993. Since then, Armenia has benefited substantially from the IAEA’s Technical Cooperation Programme under past and on-going national TC projects and from its participation in many regional TC projects in the framework of the TC Programme for Europe. The priority areas for technical cooperation (TC) with Armenia as identified in the Country Program Framework (CPF) are:

- Legislative and Regulatory Framework/Infrastructure;
- Nuclear safety and radioactive waste management;
- Nuclear power development;
- Nuclear medicine and radiation cancer therapy.

The focus for the programme is on nuclear safety, nuclear power, particularly improvement of nuclear safety of the Armenian nuclear power plant and the reliability and security of the energy supply. The TC Programme in nuclear safety is extra budgetary and supported by donors and coordinated with other assistance programmes in this field. Armenia participates in regional projects focusing on nuclear and radiation safety in order to improve its infrastructure and legislative framework to meet international standards and good practices.

TC Programmes for 2012-2013 TC cycle are the following ones:

- ARM0006: Developing and Implementing an Integrated Human Resource Management Improvement System in the Armenian Nuclear Power Sector;
- ARM6010: Establishing a Secondary Standard Dosimetric Laboratory;
- ARM6011: Strengthening Radiation Therapy Services and Establishing 3D Conformal Radiotherapy;
- ARM9020: Strengthening Nuclear and Radiation Infrastructure in Armenia;
- ARM9021: Raising Levels of Operational Safety at the Armenian Nuclear Power Plant (Phase II);
- ARM9022: Monitoring the Current Condition of the Armenian Nuclear Power Plant's Vital System, Structures and Components (SSC) and Assessing its Residual Lifetime;
- ARM9023: Ageing Management and Remaining Life-time Assessment of ANPP's SCC;
- ARM9024: Improving Nuclear Power Plant Operational Safety.

Cooperation with World Association of Nuclear Operators (WANO)

WANO Peer-Review Mission Follow-up, 2007

The objective of WANO peer-review mission follow-up in December 2007 was to verify implementation of corrective measures developed by the The Armenian NPPbased on the

WANO peer-review mission results in 2004. The mission identified the positive progress in implementation of the corrective measures and the following examples of good practice at the Armenian NPP:

- Complex self-assessment system on different levels and for main directions of activity;
- The primary leak control system in reactor cover;
- Development of standard instructions for different areas of activity;
- Development and implementation of the complex program on operation experience and the events database.

WANO Mission on Planning, Preparation and Implementation of NPP Equipment Maintenance and Repair, 2008

- The WANO mission on planning, preparation and implementation of NPP equipment maintenance and repair was conducted at the Armenian NPP in June 2008. The objective of the mission was to gain positive experience on planning, preparation and implementation of the NPP equipment maintenance and repair. The mission made recommendations on effectiveness of the program for preventing foreign materials ingression in equipment and pipelines, application of check-lists at implementation of maintenance and repair of specific equipment, development and application of documentation, periodical examination of maintenance at personnel workplaces. With respect to the mission recommendations the Armenian NPP developed and implemented corrective measures in this area. In addition, in frame of preparation to the IAEA OSART mission the Armenian NPP in 2009 conducted self assessment of "Maintenance" area. The schedule of activities to bring the existing practice in compliance with the IAEA safety standards has been developed. All scheduled measures are expected to be implemented that before the OSART Mission (planned for May 2011).

WANO Mission on Personnel Training System Improvement, 2009

- The WANO mission on personnel training system improvement was conducted at the The Armenian NPPin October 2009. The objective of the mission was to improve the approaches and principles related to organization and conduct of the personnel training. The mission made recommendations on stressing the management role in the personnel training system, development and implementation of the programs for personnel training and qualification maintaining, effective use of training tools and technical support, and also exchange of experience with training centers of other NPPs. With respect to the mission recommendations the Armenian NPP conducted comprehensive self assessment of the personnel training system and analysis of needs for improvement, organized thematic training courses for management staff, developed and submitted to the EC proposal on providing the Armenian NPP with a full scope simulator. This proposal is agreed with the EC and included in AP-2010. The project envisages transmission of the full scope simulator of the Bohunice NPP (Slovak Republic) to the Armenian NPP. At successful implementation of the project at the end of 2010 the Armenian NPP will have the full scope simulator that will allow significantly improving the effectiveness in training and maintaining qualification of the operating personnel and validation process of the emergency procedures.

Cooperation with the United States of America

Since 1996, the USG has provided assistance to improve the safety of the ANPP with total funding of approximately $50 million USD to date. Major completed projects include fire safety upgrades, nuclear service water, fast acting steam isolation valves, auxiliary make-up, safety parameter display system, plant computer, control room communications, emergency condenser, turbine generator seals, reversible motor generators, non-destructive examination capabilities, equipment maintenance, 200V circuit breakers, cooling of the battery rooms, emergency diesel generator upgrades, physical security for the plant, and the construction and initial support for the Armenia NPP Training Centre. Under the safety analysis task, the Safety Analysis Report for the Armenian NPP was recently completed and a review by the ANRA is on-going. On-going activities include support to improve the Armenia NPP training and associated infrastructure, safety and risk analysis, technical assistance with development and implementation of the Armenia NPP administrative guidelines and procedures, upgrades to the emergency diesel generator system and improvements and separation of the reactor protection system safety channels. The USNRC has provided support to the ANRA since 1995. Such support has included assistance in safety analysis methodology, physical protection, fire protection, decommissioning and training in various aspects of regulatory work. Current efforts focus on enhancing the ANRA’s regulatory oversight of the currently operating Armenian NPP (by, for example, improving ANRA’s technical capabilities for performing expert reviews of safety analysis reports developed for the ANPP), establishing the infrastructure ANRA will need to support effective regulatory oversight (including licensing and inspection) of a new nuclear power plant (by, for example, identifying the staffing ANRA will need and the technical requirements ANRA must develop) and enhancing the ANRA's nuclear safety and security regulatory oversight of radioactive sources (for example, developing and maintaining a national registry of radioactive sources).

On a broader level, the US Government has provided assistance with total funding of approximately $60 million to the RA to improve energy use efficiency, for transmission system improvements, to enhance the regulatory and business climate for electric sector investments and sector planning and management capacities. The US Government has assisted the Government of the RA in developing an understanding of the principles of least cost electric generation planning, to identify alternative generation to replace the Armenian NPP upon its closure, to attract donor or investment capital to construct such plants and to better understand the requirements of a decommissioning plan and its supporting fund. Through technical assistance on distribution and sector management, and billing and collections practice, the US Government has assisted the RA Government in ending its substantial annual losses in the energy sector and realizing a profit in recent years. Recent activities include assistance to the RA Government with support in their efforts to investigate a new nuclear power plant to replace Armenia NPP Unit № 2 including an Initial Planning Study and Draft Environmental Information Document.

Cooperation with European Commission

Armenian NPP

Since 1996, the EC has provided support in frame of the TACIS Nuclear Safety Programme and the Instrument for Nuclear Safety Cooperation (INSC) to the Armenian NPP in the most urgent nuclear safety upgrades through the on-site assistance programme.

ANRA

Since 1996 the EU has provided support to the Armenian Nuclear Regulatory Authority and, since its establishment in 2001, to its technical support organization - NRSC, through the TACIS Nuclear Safety Programme and the INSC. The TACIS Assistance has been focused on the following two main areas of co-operation.

- Direct support to the Regulatory Authority aimed at strengthening the regulatory regime in Armenia and transferring the EU regulatory methodology and practices including formulation of the nuclear legislation and regulatory documents, within the so-called Regulatory Assistance projects type;
- Technical assistance aimed at enhancing the capabilities of experts belonging to the nuclear regulator and its main TSO in the review of safety relevant upgrading and modernisation measures at Armenian Nuclear Power Plant and in the licensing of future decommissioning activities, within the so-called Technical Support (TS) projects type.

Cooperation with Czech Republic

The Czech Republic has provided technical and financial support in implementation of the safety upgrades at the Armenian NPP since 2000. Several projects have been implemented for a total amount of about more than USD 840 000. It is planned to continue this assistance in accordance with the Czech financial possibilities. The support is not large, compared with that of big countries and international institutions and fitted to the possibilities of the Czech state budget. Therefore, the Czech Republic provides its support through projects financed from other sources, such as IAEA Technical Cooperation projects, the INSC projects tasks. Therefore the reason for this support is to further improve the safety level of the plant to share actively the technical knowledge and expertise of similar of WWER reactor type.

Summary of assistance provided and the most important projects carried out by the Czech utilities and financed from the Czech and/or other sources are as follows:

- Ultrasonic testing of primary circuit and pressurizer welds and evaluation of mechanical properties of primary circuit pipes, (2005-2008); continues as Pipeline ISI, EU Project A1.01/07A1 Creation of a Database of mechanical properties of primary circuit materials, (2003);
- Monitoring of corrosion and development of erosion-corrosion models for the secondary circuit piping, (2004-2008);
- Improvement in the Physical Protection System at the Armenian Nuclear Power Plant", NSF, (2004, 2006);
- Application of the Leak Before Break Concept (2000-2002) finished, but continues as Pipe Integrity Design, EC project A1.01/07A1;

- UT of circumferential welds on pipes finished, but continues as Pipeline ISI, EU Project A1.01/07A1;
- To assess the status of the reactor vessel of Armenian NPP Unit № 2 started in 2009-2010 in frame of the IAEA TC ARM/9/022 project to finish the project on RPV lifetime assessment.

Cooperation with Russian Federation

In 2000, the Governments of the Republic of Armenia and the Russian Federation signed an agreement on the cooperation in the field of peaceful uses of nuclear energy.

For the implementation of the safety upgrades of ANPP and support to ANRA, the Government of the Russian Federation has contributed US$ 7,715,049 that were allocated to the following IAEA National TC projects for 2009-2011:

- ARM/0/006 Developing and Implementing an Integrated Human Resource Management Improvement System in the Armenian Nuclear Power Sector;
- ARM/9/020 Strengthening Nuclear and Radiation Infrastructure in Armenia.
- ARM/9/021 Raising Levels of Operational Safety at the Armenian Nuclear Power Plant (Phase II);
- ARM/9/022 Monitoring the Current Condition of the Armenian Nuclear Power Plant's Vital System, Structures and Components (SSC) and Assessing its Residual Lifetime.

SUMMARY TABLE

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 1 – External Events						
Updating PSA level 1 for external effects and seismic PSA	Planned	To be completed by the end of 2014	No	Planned	To be approved	No
Re-evaluation of the seismic stability of the confinement and identification the factual state of the building structures of the categories 1 and 2	Ongoing	To be completed by the end of 2013	No	Ongoing	To be approved	No
Development of the safety upgrading program of the Armenian NPP Unit №2 with regard to seismic safety issues and “stress-test” results	Planned	To be completed by the end of 2013	No	Planned	To be approved	No
Topic 2 – Design Issues						
Dismantling of the make-up gravitation tank	Taken		Yes	Taken		Yes
Installation of three new	Taken		Yes	Taken		Yes

snubbers on the PRZ surge line						
Seismic upgrading of the Armenian NPP Unit №2 demineralized water inventory tank	Ongoing	To be completed by the end of 2012	No	Ongoing	To be approved	No
Measures for cooling water supply to DG-4 from out fall channel using diesel pump	Taken		Yes	Taken		Yes
Justification of service water inventory sufficiency in spray ponds for 3 days.	Taken		Yes	Taken		Yes
Use of the Physical Protection Department assigned DG for the battery recharge.	Ongoing	To be completed by the end of 2012	No	Ongoing	To be approved	No
Implementation of “stress-tests” at the Armenian NPP Unit №2 in accordance with the WENRA technical specifications	Ongoing	Q3 2012	No	Ongoing	To be reviewed	No
Revision of the SAR for the Unit №2	Ongoing	To be completed by the end of 2014	No	Ongoing	To be approved	No
Seismic upgrades of high pressure pipelines of the secondary circuit on +14.7m level	Ongoing	To be completed by the end of 2012	No	Ongoing	To be approved	No

Seismic upgrades of 11 systems from the safe shutdown list	Ongoing	To be completed by the end of 2012	No	Ongoing	To be approved	No
Topic 3 – Severe Accident Management (On-Site)						
Development of severe accident management guidelines (SAMG) for ANPP	Ongoing	To be completed by the end of 2013	No	Ongoing	To be approved	No
Development of EOP for reactor shutdown condition	Ongoing	December of 2012	No	Ongoing	To be approved	No
Review of existing EOPs considering lessons learned from Fukushima accident	Ongoing	December of 2012	No	Ongoing	To be approved	No
ANPP personnel training on application of new and revised EOPs	Planned	Planned in 3 months after validation of all EOPs is completed	No	Ongoing	To be approved	No
Implementation of reactor cover emergency gas removal system	Ongoing	To be completed by the end of 2013	No	Ongoing	To be approved	No
Implementation of post-accident monitoring system	Ongoing	To be completed by the end of 2013	No	Ongoing	To be approved	No
Implementation of emergency shutdown	Ongoing	To be completed by the end of 2013	No	Ongoing	To be approved	No
Improvement of MCR habitability	Ongoing	To be completed by the end of 2012	No	Ongoing	To be approved	No
Topic 4 - National Organizations						

Identification of the main technical support organizations and of the tasks to be performed by these organizations during crisis situations	Taken	January, 2012	Yes	Taken		Yes
Financial cost estimate of technical support organization services during crisis situations	Taken	February, 2012	Yes	Taken		Yes
Issuing agreements and documents required to involve technical support organizations in the process of effective decision making during emergency situations	Planned	End of August, 2012	Yes	Taken		Yes
Topic 5 - Emergency Preparedness and Response, Post Accident Management (Off-site)						
Conduct of emergency exercises	Taken Ongoing	3 exercises per year are scheduled to be conducted	No	Ongoing	To be approved	No
Implementation of Permanent Radiation Control System at workplaces in MCR-2, ECP, in Crisis Center, in Shelters №1, 3	Ongoing	To be completed at the end of 2013	No	Ongoing	To be approved	No
Improving Automatic Control	Ongoing	To be completed	No	Ongoing	To be approved	No

System of Radiological Situation (increasing the number of measurement detectors of radiological situation outside ANPP site).		at the end of 2014				
Topic 6 – International Cooperation						
IAEA OSART mission	Taken	2011	Yes	Ongoing		Yes
IAEA EPREV mission	Planned	2012	No	Planned	Schedule is available	No
IAEA IRRS mission	Planned	2013	No	Planned	Request is to be submitted to IAEA	No
IAEA OSART follow-up mission	Planned	2013	No	Planned	TBD with ANPP and IAEA	No
Establishing a Regional Crisis Center (RCC) for NPPs with WWER reactor type on the basis of "Rosenergoatom Concern" OJSC	Taken	2012	No	Planned		Yes
Review of ANPP “stress-test” results jointly with external experts	Planned	2012	No	Planned	2012	No
Cooperation with the operators, regulatory authorities and TSOs of different countries on exchange of nuclear information	Ongoing		Yes	Ongoing		Yes

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The following documents have been referred to when preparing the present national report:

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2. Safety publication series No 50-C-S “Summary regulations on NPP safety: site selection for NPP”, IAEA, 1990, ISBN 92-0-423590-X
3. Safety publication series No 50-SG-D11 “General safety principals, taken into consideration at NPP designing”, IAEA, 1988, ISBN 92-0-423488.
4. Consideration of external effects of natural and technical character on nuclear and radiation hazardous facilities, PNAE-G-05-035-94, Moscow, 1995.
5. BDBA Review on the Basis of Scenarios of the Plant Blackout. 16CW020XR, ARMATOM, Yerevan, RA, 2006.
6. International Standard “Nuclear Energy – Light Water Reactors – Calculation of Decay Power in Nuclear Fuels. International Standard ISO 10645 First Edition, 1992-03-01. Reference number ISO 10645: 1992(E).
7. Procedure on Cooldown System Operation for 1,2 Spent Fuel Storage Tanks and Special Water Purification System-4. UE.ETD.12.-RC-015.
8. Technical Safety Justification for Operation of Vibration Resistant Profiled Assemblies of Medium Enrichment 3.82% at ANPP Unit 2. 270-Pr-024. OKB “Gidropress”.

LIST OF ABBREVIATIONS

AC	Alternating Current
AMNU	Emergency Generator Sealing Oil Pump
ANRA	Armenian Nuclear Regulatory Authority
Armenian NPP	Armenian Nuclear Power Plant
BDBA	Beyond Design Based Accident
BRU-A	Fast Acting Valve for Steam Damp into Atmosphere
BSHPT	Unit Control Board of Direct Current
BZOV	Demineralized Water Tank
CDF	Core Damage Frequency
CNS	Convention on Nuclear Safety
CNIISK	Central Building Research Institute of the former USSR
DC	Direct Current
DFC	Diagnostic Flow-Chart
DG	Diesel Generator
EC	European Commission
EPREV	Emergency Preparedness Review
ERS	Emergency Response System
INSC	Instrument on Nuclear Safety Co-operation
INSEP	International Nuclear Safeguards and Engagement Program
IPSART	International Probabilistic Safety Analysis Review Team
IRRS	Integrated Regulatory Review Services
GIP	Generic Implementation Procedure
MCR	Main Control Room
MES	Ministry of Emergency Situations of RA
MSV	Main Stop Valve

NBO	Boron Purification Pump
NRSC	Nuclear and Radiation Safety Center
NZB	Refueling Water Pump of Cooling Pond
OSHPT	Plant Direct Current Control Board
OSART	Operational Safety Review Team
PAZ	Protective Actions Zone
PSA	Probabilistic Safety Assessment
PGA	Peak Ground Acceleration
PRZ	Pressuriser
RA	Republic of Armenia
RCC	Regional Crisis Centre
RCP	Reactor Coolant Pump
RCP	Regional Crisis Center
RPV	Reactor Pressure Vessel
RLE	Reviewed Level Earthquake
SAM	Severe Accident Management
SAR	Safety Analysis Report
SV	Safety Valve
SG	Steam Generator
SAMG	Severe Accident Management Guideline
SSC	Systems, Structures and Components
STT	Serious Threat Tree
TSG	Technical Support Group
US DOE	USA Department of Energy
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators Association