

**NATIONAL REPORT  
OF REPUBLIC OF ARMENIA  
UNDER  
CONVENTION ON NUCLEAR SAFETY**

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# 4-TH NATIONAL REPORT OF REPUBLIC OF ARMENIA UNDER CONVENTION ON NUCLEAR SAFETY

## INRODUCTION

On 20 September 1994 Republic of Armenia has signed the Convention on Nuclear Safety (hereinafter referred to as the Convention) that was further adopted during the Vienna Diplomatic Conference on 17 June 1994. The Convention entered into force on 24 September 1997 by ratification.

This report has been drawn in accordance with the provisions of Article 5 of the Convention and contains information on implementation of obligations undertaken by Republic of Armenia.

## CHAPTER 1. GENERAL PROVISIONS

### 1.1. Existing Nuclear Installations

#### *ARTICLE 6. EXISTING NUCLEAR INSTALLATIONS*

*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. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shutdown may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.*

In Republic of Armenia the Convention is applied to one nuclear installation - the Armenian NPP consisting of two WWER-440 units. The Armenian NPP is located 28 kilometers west of Yerevan, the capital of Armenia. There is a dry spent fuel storage facility located on the Armenian NPP site. The technical specifications of the Armenian NPP and the dry spent nuclear fuel storage facility are provided in the second national report of Armenia.

The Armenian NPP Unit № 1 was put into operation in 1976 and the Unit № 2 in 1980. In 1989, after the earthquake occurred in Armenia in December 1988, both units were shutdown under the USSR Government Decree, though the earthquake didn't impact the Armenian NPP and both units remained in operation.

In April 1993 due to the energy crisis the Government of Armenia (hereinafter referred to as the Government) made decree to restart the Armenian NPP Unit № 2.

Thus, the Armenian NPP Unit № 2 was restarted in November 1995; the Unit №1 is in a condition of conservation after final shutdown in 1989. After restart the Unit № 2 is operated with the capacity  $N_T = 92$  %. Annually in average the Armenian NPP generates 40-45 % from the total energy generated in Armenia.

In 2006 the Government adopted decree on commencement of preparatory activities for new NPP construction. Armenian, American and Russian specialists are currently developing the task order on feasibility studies for new NPP construction. The program for decommissioning of both units is being developed jointly with international experts.

In 2007 under the Government Decree there was established a Commission comprising of government members empowered to manage financial resources of the fund established for decommissioning of both units of the Armenian NPP (Government Decree № 532-A as of 03.05.2007 on approval of composition of a commission on management of special account for decommissioning of Armenian NPP).

In 2005 the Government made a decision on extension of the dry spent nuclear fuel storage facility in order to store the accumulated fuel and to ensure further operation of the Armenian NPP. The

existing NUHOMS type storage system has been selected; it will consist of 24 modules where 1344 fuel assemblies can be housed. The commissioning of first 12 modules is planned for the first half of 2008 and the commissioning of the next 12 modules - in 2012.

On 23 June 2005 the Government approved the Energy Development Strategy in the context of economic development of Armenia that in particular specifies:

- Provision with safe operation of Armenian NPP up to 2016 or until it can be replaced by other energy sources and decommissioned without significant economic, social, environmental and energy impacts.

The following directions of energy development strategy are emphasized to provide with energy safety and security:

- Use of recoverable resources and energy saving,
- Nuclear energy,
- Diversification of energy supply resources and regional integration,
- Social policy, financial stability and economical effectiveness.

Following internationally accepted principles for energy independence the optimal structure of energy production for Armenia is as follows:

- Priority should be given to use in maximum extent capacities of recoverable energy sources– hydro, wind and geothermal and sun. It is necessary to take into account that the capacities of mentioned energy sources are of seasonal nature.
- New NPP units and thermal power stations will complement to energy production in Armenia.

## **CHAPTER 2. LEGISLATION AND REGULATION**

### **2.1. Legislative and Regulatory Framework**

#### ***ARTICLE 7. LEGISLATIVE AND REGULATORY FRAMEWORK***

- 1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.*
- 2. The legislative and regulatory framework shall provide for:*
  - I. the establishment of applicable national safety requirements and regulations;*
  - II. a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;*
  - III. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;*
  - IV. the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.*

In a period from 2004 to September 2007 the Law on Safe Utilization of Atomic Energy for Peaceful Purposes was supplemented and amended as of 09.11.2004, 15.12.2005, 22.02.2007 respectively.

The amendments and supplements as of 09.11.2004 stipulate:

- Ownership rights of legal entities for new constructed nuclear installations. The existing NPP remains the State-owned,
- Accumulation of financial resources for decommissioning of nuclear installations,
- Extension of rights and responsibilities of the regulatory body (e.g. responsibility to implement environmental radiation monitoring and control, right to conclude international agreements, right to adopt ministerial acts and so on).

The amendments as of 15.12.2005 and 22.02.2007 are aimed to clarify and facilitate licensing process in atomic energy unitization field.

In 2006 the Government approved the norms and rules on radiation safety (Government Decree № 1219-N 18.09.2006 and Government Decree № 489-N 18.09.2006) developed with account taken to IBSS 115 and other IAEA regulations and ICRP.

With the purpose to meet the requirements specified in the Law on licensing, the licensing procedures in atomic energy utilization field, including the procedures for licensing of nuclear installations and NPP personnel were approved by the Government in 2004-2006.

List of national laws and regulations is provided in Annex 1.

### ***Licensing of Armenian NPP***

The license for operation of the existing NPP is valid for 10-years period.

In accordance with the licensing procedures applicant should submit to ANRA application and the following supporting documents:

- Document describing organizational chart of Armenian NPP,
- Document describing system of training and retraining of personnel holding positions important to safety,
- Document stating information on financial means allocated for safe operation, modification, engineering and technical support and decommissioning,
- Safety analysis report,
- Report on probabilistic safety analysis (Level I),
- Quality assurance program,
- Emergency response plan,
- Fire protection plan,
- Technological specification and instruction on operation,
- Program on testing and maintenance of safety important systems,
- Other documents as required in the licensing procedure.

### ***Licensing of NPP Personnel***

NPP personnel holding positions important to safety, as stipulated in the Government Decree № 768 as of 22 December 1999, are subject to licensing.

To obtain license NPP personnel should submit application and following documents:

- A copy of diploma,
- Medical certificate confirming absence of contraindications,
- Employment records,
- And so on.

Licensing process consists of review of documents submitted by applicant and examination of his qualification.

If submitted documents meet the licensing requirements licensee is allowed for examination, which is conducted by ANRA commission. Examination consists of two stages: test in writing and interview.

Licence is granted if licensee successfully passes examination. For operational personnel license is granted for 2-years period and for managerial staff of NPP - for 3-years period. When validity of licence expires the above described procedure is repeated.

## **2.2. Regulatory Body**

### ***ARTICLE 8. REGULATORY BODY***

- 1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*
- 2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.*

Detailed information about ANRA is provided in the previous national reports.

Inspectorate for state regulation of nuclear and radiation safety within the Ministry for Nature Protection– ANRA, is the state regulatory body for nuclear and radiation safety in the RA. Rights and responsibilities of ANRA are established in the Law on Safe Utilization of Atomic Energy for Peaceful Purposes and its Statute.

ANRA statute was approved under the Government Decree № 2183-N as of 26 December 2002 (as amended on 04.03.2004, 01.12.2005).

ANRA is independent from organizations responsible for development and use of nuclear energy. The status of ANRA within the Government and also its organizational chart are provided in Annexes 3 and 2 respectively.

ANRA is funded from the State Budget.

According to the above mentioned, ANRA:

- Develops and submits, through the Minister for Nature Protection, drafts of safety norms and rules to the Government,
- Assesses safety in atomic energy utilization field,
- Licenses practices and physical persons holding positions important to safety in the atomic energy utilization field,
- Controls the fulfillment of requirements established in the legislation on atomic energy utilization field and in issued licenses,
- Withdraws a license in case of non-compliances with the licence terms and condition,
- Controls the preparedness organizations involved in the national emergency response system,
- Jointly with the state authority entrusted by the Government with responsibility for international relations, within its jurisdiction, controls the fulfilment of the commitments of Armenia pursuant to the international treaties which it has ratified,
- Cooperates with the competent international and foreign organisations on safety related issues,
- Controls the safeguards applicable to nuclear materials,
- Performs the state regulation of physical protection of atomic energy utilization installations and of nuclear materials,
- Conducts inspections of atomic energy utilization installations and of activities implemented there,
- Implements environmental radiation monitoring and control,

- Imposes enforcement actions if non-compliances with requirements of the legislation and license terms are detected,
- Exercises other rights established in the legislation.

### **2.3. Responsibility of the Licence Holder**

#### ***ARTICLE 9. RESPONSIBILITY OF THE LICENCE HOLDER***

*Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.*

The Armenian NPP as the operating organization bears the ultimate responsibility for safety, according to the Law on Safe Utilization of Atomic Energy for Peaceful Purposes.

The Armenian NPP from a product consumption (services rendered) in atomic energy utilization field shall allocate financial assignments for nuclear, radiation, and technical safety, fire protection, physical protection, nuclear material account and control, implementation of safety improvement measures, scientific and technical support, as well as securities needed for storage of spent nuclear fuel and for decommissioning.

Financial securities for decommissioning of nuclear installations are accumulated on a special account of the Ministry of Finance and Economy (Government Decree № 1637-N as of 16.10.2006 on opening a special account for decommissioning of Armenian NPP). The use of these financial resources in other purposes is prohibited.

To fulfill its responsibilities for safety, Armenian NPP:

- Develops and performs activities on safety provision,
- Ensures the introduction of the safety culture,
- In the prescribed form periodically submits reports on safety to the regulatory authority,
- Develops the quality assurance program for every stage of lifetime (site selection, design, construction, commissioning, operation, decommissioning) and ensures its implementation;
- In the prescribed form organizes the personnel dose limit control,
- In the prescribed form organizes and conducts investigations of incidents and accidents occurred during the operation of atomic energy utilization installation,
- In the prescribed form develops the response plan for emergencies occurred in the atomic energy utilization installation and ensures the preparedness of personnel and necessary resources for its implementation,
- Develops the program of activities for fire protection and ensures its implementation;
- Organizes the recruitment and training of skillful personnel,
- Provides the personnel with sanitary and social conditions in accordance with the current regulations,
- Periodically makes the safety assessment to ascertain its correspondence to the newest safety requirements,
- Establishes the services that control the nuclear and radiation safety,
- Organizes the permanent radiation situation control in the controlled and supervised areas of the atomic energy utilization installation,
- In the prescribed form periodically provides the governor and to the mayor of Yerevan of the territory included in the supervised area of the Armenian NPP with information on the radiation situation in the supervised area,

- Performs other authorities stipulated in the legislation.

## **CHAPTER 3. GENERAL SAFETY CONSIDERATIONS**

### **3.1. Priority to Safety**

#### ***ARTICLE 10. PRIORITY TO SAFETY***

*Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.*

Pursuant to Article 5 of the Law on Safe Utilization of Atomic Energy for Peaceful Purposes the Republic of Armenia shall implement such a policy in atomic energy utilization field where priority is given to safety.

Pursuant to Article 18 point “i” of the Law on Safe Utilization of Atomic Energy for Peaceful Purposes and the Government Decree № 1858-N as of 14.12.2006 ANRA licenses physical persons holding positions important for safety in atomic energy utilization field.

Pursuant to the Government Decree № 1858-N as of 14.12.2006 the following NPP personnel should be licensed:

- Director,
- Chief engineer,
- Deputy director for physical protection,
- Deputies of chief engineer,
- Shift supervisors of NPP,
- Chief supervisor of reactor hall,
- Leading engineer for reactor control,
- Leading engineer for turbine control.

In 1996 the Nuclear Safety Council under the President of Armenia was established under the President Ordinance. The Council comprises of recognized authorities in nuclear science and technology from Germany, United Kingdom, France, USA, Russia, IAEA and other countries and organizations.

During the regular sessions of the Council the management of Armenian NPP operating organization and ANRA submit progress reports on the Armenian NPP safety. Implementation of recommendations made by the Council is under the control of the President of Armenia.

### **3.2. Financial and Human Resources**

#### ***ARTICLE 11. FINANCIAL AND HUMAN RESOURCES***

- 1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.*
- 2. Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.*

#### **3.2.1. Financial Resources of Armenian NPP**

Detailed information about financial resources of Armenian NPP is provided in the previous national reports and in answers to the questions posted to Armenia in 2005.

### **3.2.2. Human resources of Armenian NPP**

Detailed information about human resources of Armenian NPP is provided in the previous national reports.

### **3.2.3. Financial Resources of Regulatory Body**

ANRA is financed from the State Budget. ANRA's budget for 2007 is 100 mln Armenian Drams (AD) ( $\approx 300,000$  USD), which is for 10 mln AD more than in 2006. This amount is intended for additional funding of Nuclear and Radiation Safety Center - ANRA's TSO (detailed information about NRSC is provided in the points 3.2.4 and 3.2.5).

### **3.2.4. Human Resources of Regulatory Body**

16 specialists were employed in ANRA up to 2005.

In 2005-2007 4 specialists with significant work experience in nuclear energy field were recruited. Currently ANRA employs 20 specialists (as of September 2007): all have university degree, 5 out of 20 are PhD.

ANRA implements systematic program of maintaining and improvement its personnel qualification through re-training in international training courses and seminars and also through implementation of individual training plans.

ANRA receives significant support from NRSC, which is directly subordinated to ANRA.

Under yearly contracts NRSC develops drafts laws, regulations, and guides, performs calculations, expertise, assessment and so on, participates in inspections. The majority of NRSC staff was formerly employed in ANRA.

### **3.2.5. Technical Support**

NRSC employs 25 staff members and 23 contracted specialists. In the reporting period NRSC provided technical support to ANRA in the following areas:

- Development of drafts of laws, regulations, guides,
- Implementation of Seismic Safety Re-evaluation Program of the Armenian NPP Unit 2,
- Review of Safety Analysis Report of Armenian NPP,
- Review of PSA report of Armenian NPP,
- Assessment of core properties of Armenian NPP Unit 2 with the purpose to verify compliance of new refueling properties with the safe operation requirements,
- Review of SAR of new spent fuel storage facility,
- Expertise of safety justification documents submitted by Armenian NPP in support to obtaining licenses for Armenian NPP safety improvement measures.

Researches and developments made by NRSC for ANRA include:

- Development of burn-up dependent cross-sections library for VVER-440 fuel and control assemblies has been completed. Reactor core model was developed based on PARCS (package for analysis of physical processes in reactor core),
- Use of mathematical model of PSA for identification for emergency scenario capable of resulting of cold pressurization on Armenian NPP unit 2 reactor,
- Calculation of peaking pressure for accidents due to primary coolant leakage with regard to accumulation and ignition of hydrogen during accident,

- Partial improvement of physical model of TRITON package for modeling hexagonal fuel lattice. There was developed a model of WWER 440 fuel assembly for TRITON package,
- Seismic capacity evaluation of Armenian NPP unit 2 building structures,
- Assessment and summarization of Armenian NPP safety improvement measures have been made jointly with experts of Gesellschaft für Anlagen-und Reaktorsicherheit (GRS),
- Training program and materials has been developed with the purpose to provide personnel training for newcomers of ANRA on nuclear and radiation safety,
- Other activities aimed in to support ANRA’s regulatory performance.

NRSC proceeds with studying new methodologies in the area of safety analysis. There has been developed static model of Armenian NPP core for KENO-VI code of SCALE-5 package. Model was developed for criticality analysis of Armenian NPP core spurious loadings. Cooperation with EU JRC in the area of ageing analysis for NPP PSA has been started. NRSC is involved in working group in frame of APSA European Network for exchange of information and experience in the area equipment ageing implementation in PSA. In the reporting period the NRSC specialists published 12 scientific and technical reports. Training of young specialists for ANRA and NRSC is in process.

### **3.3. Human Factors**

#### ***ARTICLE 12. HUMAN FACTORS***

*Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.*

One of important safety factors during operation of nuclear installations is account for human factor and its control.

In this regard, human factors affecting the working environment, appropriateness of personnel to carry out his duties and on effectiveness of its practices have been identified and are taken into account in daily operations.

Management of human factor at Armenian NPP is implemented by:

- Making personnel aware and understanding of importance and priority of safety,
- Increasing level of knowledge and competence through training and self-training,
- Motivation of activities by determination and explanation of objectives, establishment encouragement and punishment system,
- Clear allocation of responsibilities by establishing and description of duties ,
- Contributing to maintaining and improvement of safety culture,
- Provision with adequate resources for management and implementation of practices.

Armenian NPP implements self-assessment practice on different levels, including self-assessments of safety culture and safety management systems. These self-assessments allow detecting areas for improvement concerned with human factor management, development and implementation of corrective measures to increase effectiveness of human factor management.

With regard to the mentioned above, ANRA implements regulatory control in the following areas:

- Control and assessment of NPP personnel training (licensing of personnel implementing practices important to NPP safety, control and assessment of personnel training process, methodology, means and programs, control of training center activity),
- Control of professional qualification of NPP personnel (in particular analysis of human errors, quality control and quality management, control over compliance with the requirements established in safety regulations),

- Approval of technical solutions and design changes from ergonomic aspect and account for human factor (in particular review and approval of technical solutions and design changes in the safety important systems).

### 3.4. Quality Assurance

#### **ARTICLE 13. QUALITY ASSURANCE**

*Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.*

New version of quality assurance program for NPP Operation complying with the IAEA Safety Series No. 50-C/SG-Q Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations was developed and implemented in 2004. The quality assurance program for NPP operation covers 30 directions affecting the safe operation of Armenian NPP and includes declaration made by the management on safety and quality policy. Armenian NPP commenced development of administrative and technical documentation, which specifies all these types of practices, and describe all management processes. For continuous improvement of management system the quality assurance program for NPP operation foresee periodical audits of all areas, including audits of quality systems of subcontractors. All quality management related practices are implemented in accordance with the international quality management standards, in particular IAEA Safety Guide GS-G-3.1 “Application of Management Systems for Facilities and Activities” and ISO 9001-2000 standard.

ANRA has established and implements a process oriented quality management system which fulfills the requirements of ISO 9001-2000 standard that was certified by Det Norske Veritas in November 2004.

### 3.5. Assessment and Verification of Safety

#### **ARTICLE 14. ASSESSMENT AND VERIFICATION OF SAFETY**

*Each Contracting Party shall take the appropriate steps to ensure that:*

- I. comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;*
- 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.*

#### **Safety Analysis Report of Armenian NPP**

A safety analysis report (SAR) of Armenian NPP Unit № 2 has been developed with regard to requirements to content and form of SAR of Armenian NPP Unit № 2. Besides Armenian NPP specialists, local technical support organizations (“Armatom”, “Atomservice”) were involved in development of SAR. Specialists of Argon National Laboratory (ANL) of USA assisted with development of separate chapters of SAR.

At the end of April 2007 Armenian NPP convened a meeting with participation of all experts involved in development of SAR for discussion of expertise results. Afterwards SAR was submitted to the NRSC for expertise for further submission for ANRA’s review.

Besides, Armenian NPP plans to co-operate with ANL in future in the frame of SAR activities including:

- Revision of SAR based on ANRA comments and recommendations,
- Environmental equipment qualification,
- Protection against internal “missiles”,

- High energy pipeline breaks.

There have been made calculations for accidents included in the list of design and beyond design accidents. For a number of accidents calculations have not been carried out as far as implementation and development of new models of Armenian NPP based of PARCS code is required (reactivity accidents).

Specialists NRSC, “Armatom” and Armenian NPP with support of USA specialists completed development of neutron physics constants for PARCS code. In parallel adaptation and development of reactor core model based on PARCS is in process.

Verification and validation of Armenian NPP confinement model have been completed. Analysis of radiological consequences has been initiated.

### ***Seismic Safety***

In the reporting period measures included in the “Seismic Safety Reevaluation Program for Armenian NPP Unit 2” developed according to the IAEA guidelines were implemented.

7 main tasks emphasized in the program have been completed and discussed with IAEA experts (see Annex 7, Reference- Flowchart of Seismic Safety Reevaluation Program):

- Reviewed Level Earthquake,
- Collection of as-built data and seismic related information,
- Geotechnical data,
- Safe shutdown equipment list and safe shutdown procedure,
- Soil-structure interaction analysis, floor response spectra generation for main building and redundant DG,
- Soil capacity evaluation,
- Seismic capacity analysis of main and diesel generator building structures and ventilation stack structure,

Agreement has been reached to conduct seismic walkdown with support of IAEA and DOE during outage-2007 with experts from Western organizations experienced in this area.

For PSA purposes probabilistic seismic input for seismic PSA analysis based on available database has been developed.

### ***Probabilistic Safety Analysis***

Armenian NPP PSA activities were initiated in 2002. PSA for fire, flooding, internal and external events have been completed in 2004. Review of existing models detected uncertainties in internal events model. In 2004 NRSC, ARMENIAN NPP, Risk Engineering (Bulgaria) and Jacobsen Engineering (Great Britain) initiated updating PSA model for internal events.

In 2006 updating of PSA model for internal events has been completed. As a result, large spectra of initiating events those are possible to occur during operation of unit on full power. Assessment of reliability of safety systems and some normal operation systems important to safety of Armenian NPP has been performed.

Calculation of PSA model demonstrated that the core damage frequency is  $7.58E-05$  1/year (with application of conservative assumptions). Currently more detailed analysis of obtained risk profile is carried out; the analysis will allow detecting a number of latent safety deficiencies of Armenian NPP and eliminate excessive conservatism of models and assumptions.

Preparations to upcoming IAEA IPSART mission aimed to verify the quality of the analysis carried out are being made. The objective of IPSART mission is a detailed review of reports and models of

Armenian NPP PSA, detection of uncertainties and weaknesses in the analysis performed. As a result there will be prepared a mission report that will include recommendations on PSA improvement. The IPSART mission is planned for October 2007.

Application of PSA for implementation of risk-informed approaches for decision making in nuclear and radiation safety is planned.

Application of PSA will allow implementing the following tasks:

- Continuous safety assessment (living PSA, risk criteria),
- Risk-informed technical specification,
- Risk-informed improvement of Armenian NPP procedures,
- Risk-informed prioritization of modifications,
- Risk-informed tests and maintenance,
- Personnel training based on PSA results (focusing training programs on separate areas emphasized by PSA, emergency exercises by PSA defined scenarios),
- Risk-informed analysis of Armenian NPP events (deterministic analysis, application of PSA models, analysis of root causes, risk monitoring),
- Risk-informed in-service inspection.

### **3.6. Radiation Protection**

#### ***ARTICLE 15. RADIATION PROTECTION***

*Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.*

#### **3.6.1. Legislative and Regulatory Framework**

Radiation safety related issues are governed under following legal acts:

- Law of the RA on Safe Utilization of Atomic Energy for Peaceful Purposes (entered into force on 1 February 1999),
- Law of the RA on Licensing (entered into force on 30 May 2001),
- Law of the RA on population protection in emergency situations (entered into force on 1 March 1999),
- Government Decree № 1219-N as of 18 August 2006 on approval of radiation safety norms,
- Government Decree № 1489-N as of 18 August 2006 on approval of radiation safety rules.

#### **3.6.2. Occupational and Public Exposure Dose Limits**

##### **3.6.2.1. Fulfillment of Conditions for the Release of Radioactive Materials**

Actual releases of radioactive materials from Armenian NPP are provided on figures 1, 2 and 3.

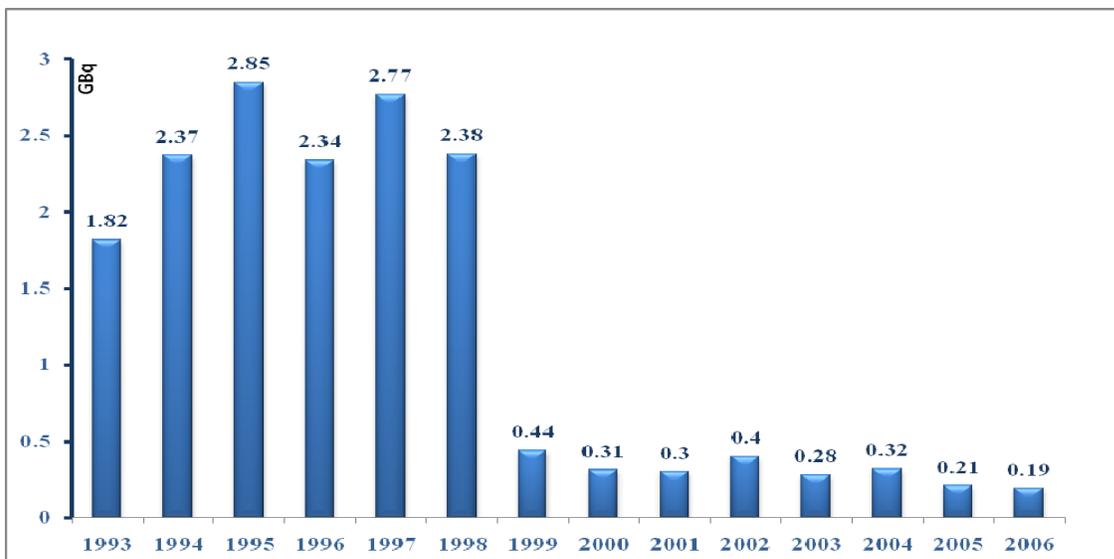
Airborne releases from Armenian NPP are controlled by devices installed on vent pipe (height 150 m); discharges through the sewerage system are controlled by automatic system (installed in 2005 in frame of IAEA project) and laboratory sample measurements.

Figure 1 provides volumetric gross activities of airborne releases from Armenian NPP.

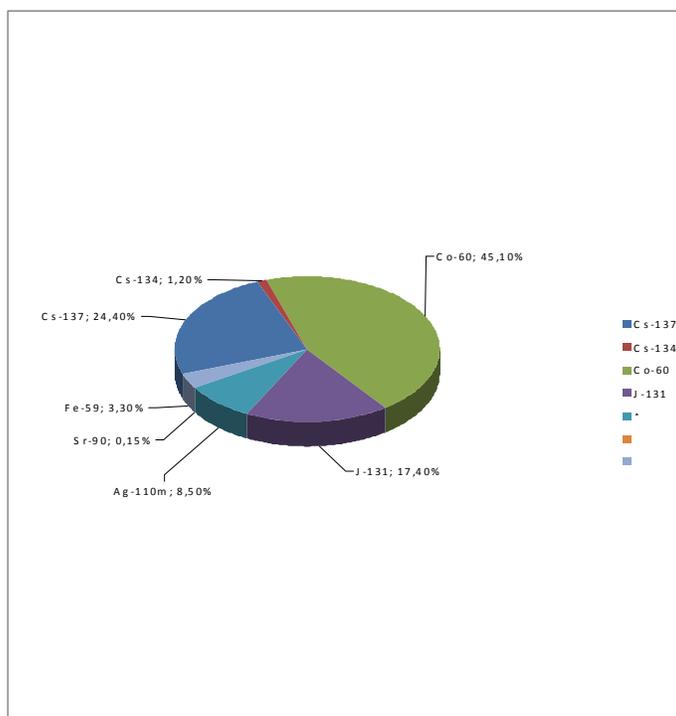
Figure 2 provides with percentage of radionuclides in airborne releases. Airborne releases contain such radioactive isotopes as  $^{137}\text{Cs}$  and  $^{131}\text{I}$ , and also  $^{60}\text{Co}$ ,  $^{110\text{m}}\text{Ag}$ ,  $^{59}\text{Fe}$  and so on. Contents of  $^{90}\text{Sr}$  in airborne releases from Armenian NPP is insignificant. In the reporting period the quantity of

released inert gases was 27 TBq in average (allowable release is 2708 TBq). Device on measurement of radioactive isotopes  $^3\text{H}$  and  $^{14}\text{C}$  is being installed.

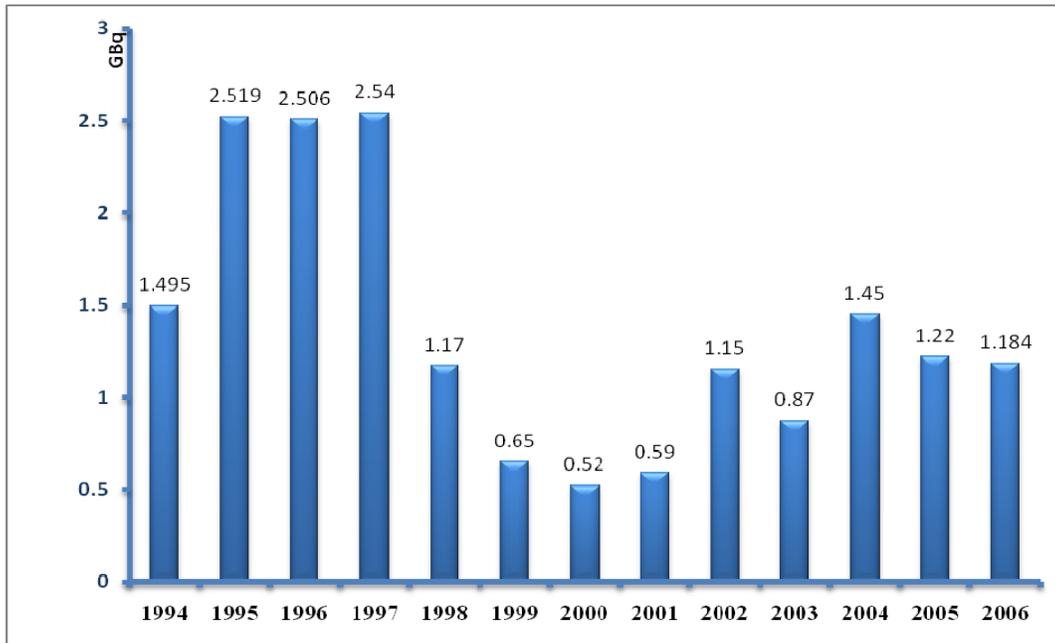
Figure 3 provides results of laboratory measurements of discharges from the sewerage system. As it is shown on the figure the contents of radionuclides is lower that maximum permissible level. Low contents of radionuclides in discharges and releases from Armenian NPP is explained by reliability of barriers and also high level of purification rate of gas relief (98%).



**Figure 1. Annual Releases of Long-lived Radionuclides (T1/2 more than 24 hours) in the period of Operation (maximum permissible annual limit is 203 GBq)**



**Figure 2. Percentage of separate radionuclides (Ag, Sr, Fe...) in total discharges from Armenian NPP within 2006**



**Figure 3. Annual Discharges of Long Lived Radionuclides (Sr+Cs) from Armenian NPP in the period of Operation (value of annual release is 55.5 GBq)**

### 3.6.2.2. Steps Taken to Ensure that Radiation Exposures are Kept As Low As Reasonably Achievable

As it is shown on Figure 4, the collective exposure dose of Armenian NPP personnel decreases. For instance in a period of refueling and outage in 2006 the collective exposure dose 0.92 man/Sv was expected, however the actual exposure dose was 0.65 man/Sv.

The increased individual doses for 1995 as shown on Figure 5 are conditioned by restart measures implemented at Armenian NPP after 5-years shutdown. Insignificant increase of individual equivalent dose for 2006 is conditioned by large scope of measures implemented during the refueling and outage, in particular by replacement of neutron flux detectors and implementation of other safety improvement measures.

Control of Armenian NPP personnel internal exposure is implemented annually after the refueling and outage and as appropriate. Maximum individual dose from nuclides ( $^{137}\text{Cs}$ ,  $^{54}\text{Mn}$  and  $^{60}\text{Co}$ ) accumulated in lungs is 1.7 mSv/year.

ALARA committee has been established at Armenian NPP. The committee has developed measures aimed to decrease personnel exposure doses. Special procedures for organizing and implementing radiation hazard activities, dose loads account, and also specific measures to decrease personnel exposure doses have been implemented at Armenian NPP.

### 3.6.2.3. Environmental Radiological Surveillance

The monitoring system has been established in the supervised area (10km) to determine the environmental impact of Armenian NPP. Exposure control of population residing in the NPP supervised area is implemented by:

- Environmental sampling (air, water, vegetation, food and so on),
- Measurement of dose rates in different points of the supervised area,
- Measurement of population exposure dose by TLD dosimeters.

According to systematic measurements, gamma dose rate on the territory of the supervised area was

0.08-0.09  $\mu\text{Sv}/\text{hour}$ . In certain areas of the Armenian NPP site the dose rate was 0.22  $\mu\text{Sv}/\text{hour}$ .

According to results of integrated dosimeters, the population exposure dose is 1.87mSv per year. Comparing these values with the averaged results of the population exposure doses before the Armenian NPP start-up in 1977 (“zero background”), which was 1.65 mSv (0.8 mSv from cosmic exposure and 0.85 mSv from natural and artificial radionuclides of soil), it can be concluded that the population exposure doses are on the same level as before the Armenian NPP start-up in 1977.

The aspiration devices are installed around the Armenian NPP for measurement of contents of radionuclides in atmosphere. The measurement results show that the main radionuclides contained in atmosphere are  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$  and  $^7\text{Be}$ , the activity of which in the supervised area in average is  $0.03/\text{E}-4\text{Bq}/\text{m}^3$ ,  $0.019/\text{E}-4\text{Bq}/\text{m}^3$  and  $13.4.2/\text{E}-4\text{Bq}/\text{m}^3$  respectively.

Sedimental and air samples taken from the same areas show that contamination in sediments is  $^{137}\text{Cs}$  -  $1.22\text{E}+7\text{Bq}/\text{km}^2$  per quarter,  $^{90}\text{Sr}$  -  $0.91\text{E}+7\text{Bq}/\text{km}^2$  per quarter and  $^7\text{Be}$  –  $12.5\text{E}+7\text{Bq}/\text{km}^2$  per quarter.

Soil and vegetation samples taken on in the supervised area on different distances from Armenian NPP show that:

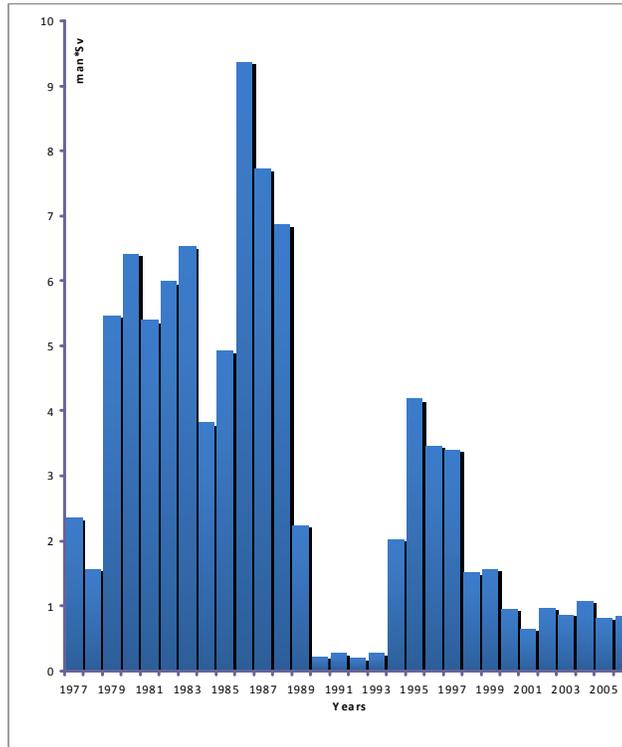
- Soil -  $^{137}\text{Cs}$ - 14.0 Bq/kg,  $^{90}\text{Sr}$  –8.4 Bq/kg,
- Vegetation -  $^{137}\text{Cs}$ - 4.2 Bq/kg,  $^{90}\text{Sr}$  –3.1 Bq/kg.

No other radionuclides generated at the NPP have been detected in the above mentioned samples.

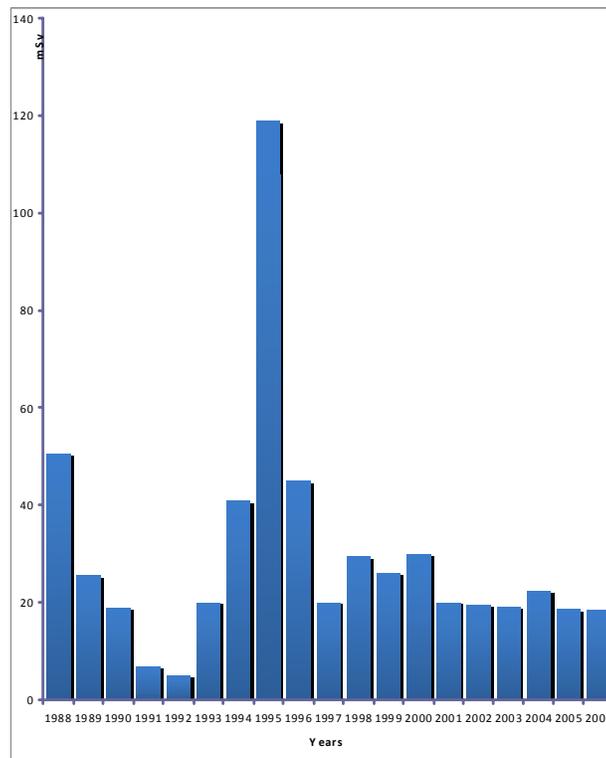
The radiation safety norms establish allowable levels of radionuclides contents in the drinking water.

The allowable concentration of discharged water from the Armenian NPP by summary gross activity has been established equal to 7.4 Bq/l. Actual data of liquid discharges from Armenian NPP are provided in the Figure 3.

Waters discharged from the Armenian NPP are additionally purified in special purification facilities (5.5 km from Armenian NPP). Water from these purification facilities inflows in the Sev Jur River. According to the monitoring program samples are taken from the Sev Jur River in a distance 100m from the discharge area towards the water flow. Average annual summary gross activity of the Sev Jur River are 1.2 Bq/l,  $^{137}\text{Cs}$  - 0.11Bq/l and  $^{90}\text{Sr}$  - 0.025Bq/l.



**Figure 4. Annual Collective External Exposure Dose of Armenian NPP Personnel in the period of Operation**



**Figure 5. Maximum Individual Equivalent Dose of Armenian NPP Personnel for 1988 – 2006**

### 3.7. Emergency Preparedness

#### **ARTICLE 16. EMERGENCY PREPAREDNESS**

- 1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.  
For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.*
- 2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.*
- 3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.*

#### **3.7.1. Legislative Framework**

In Armenia the main legal act settling relations concerned with response to nuclear and radiation emergencies are:

- Law of the RA on Safe Utilization of Atomic Energy for Peaceful Purposes,
- Law of the RA on Population Protection During Emergencies,
- Plan on Protection of Population in case of Nuclear and Radiation Emergencies at Armenian NPP (off-site emergency plan of Armenian NPP) approved under the Government Decree № 2328 as of 22.12.2005,
- Basic requirements to emergency planning and response at nuclear and radiation emergencies,
- Norms on Radiation Safety,
- Rules on Radiation Safety.

#### **3.7.2. Structure of the National Emergency Response System**

The key organizations of the national emergency response system are Armenian NPP, Rescue Service of Armenia and ANRA.

Armenian NPP is responsible for classification of emergency situation at NPP, prompt notification about emergency situation, bringing the reactor in safe condition and NPP personnel protection.

Rescue Service of Armenia functions as the national coordinator in organization and implementation of population protection measures. To cope with this task Rescue Service operates analytical and information center equipped with modern equipment and communication means. Rescue Service is the competent authority and the contact point under the Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency.

ANRA is the national advisor in organization of response and also the contact point under the Convention on Early Notification about Nuclear Accident. To cope with this task ANRA operates appropriately equipped emergency response center and has a relevantly trained emergency personnel. With support of NRSC and external experts 13 emergency procedures have been developed. The procedures specify reactor condition assessment, assessment of radiological situation of Armenian NPP and adjacent territories, prognosis on situation change, development recommendations on radiation protection of Armenian NPP personnel, emergency personnel and population and other.

### **3.7.3. Classification of Emergency Situations**

System for classification of emergency situations is a part of Armenian NPP on-site emergency plan. The classification of emergency situations is made based on symptom-oriented analysis of situation in Armenian NPP and its adjacent territories. The system has been developed based on IAEA Safety Standard GS-R-2.

### **3.7.4. National Emergency Preparedness Scheme**

The plan for protection of population at nuclear and radiation emergencies at Armenian NPP (off-site emergency plan of Armenian NPP) developed with account taken to requirements of GS-R-2, GS-G-2.1 and EPR-METHOD-2003, has been enforced since December 2005. The plan establishes functions of organizations involved in the national emergency response system, procedure for the system activation, implementation of protective measures, radiation and dosimetric monitoring, medical, police, transport and material support for response, and also estimates of material, human and technical resources required to carry out population protection measures.

In July 2006 there were conducted emergency exercises aimed to verify procedures for notification of organizations involved in the national emergency response system and population, communication link, organization of evacuation of population in certain settlements.

### **3.7.5. On-site Emergency Plan of Armenian NPP**

Armenian NPP plan for response to nuclear and radiation emergencies (on-site emergency plan of Armenian NPP) has been enforced since December 2005. The plan meets the requirements specified in the basic requirements to planning and response to nuclear and radiation emergencies and IAEA recommendations.

### **3.7.6. Notification about Event**

Responsibilities for notification about nuclear and radiation emergencies at Armenian NPP are specified in Basic requirements to planning and response to nuclear and radiation emergencies and fixed in emergency response plans.

According to the above mentioned regulations the responsibilities for notification rest with:

- Personnel of Armenian NPP – responsible for notification of population residing in preventive actions zone,
- Local authorities and if necessary the Rescue Service of Armenia –responsible for notification of population residing in urgent protective actions zone,
- ANRA – responsible for international notification about nuclear and radiation emergencies at Armenian NPP, and for receiving information about emergencies occurred in nuclear installations of other countries.

### **3.7.7. Emergency Training and Exercises**

In accordance with the approved schedules emergency training and exercises are regularly conducted with the purpose to maintain continuous emergency preparedness of Armenian NPP personnel and organizations involved in the national emergency response system.

In July 2006 there were conducted emergency exercises aimed to verify procedures for notification of organizations involved in the national emergency response system and of population, communication links, organizing evacuation of population in certain settlements.

At the end of 2007 with the purpose to verify on-site emergency plan of Armenian NPP it is planned to conduct exercises for Armenian NPP personnel.

Full scope national exercises with participation of all organizations involved in the national emergency response system and also external specialists are planned for the end of 2008.

### **3.7.8. International Cooperation**

Republic of Armenia is a party to a number of international treaties and conventions on emergency response and planning related issues (Annex 1).

Armenian organizations and authorities cooperate with IAEA (in frame of technical cooperation projects), USA, United Kingdom and also EC (in frame of TACIS) on different issues related to emergency response and planning.

On 15 March 2007 the Arrangement between the Nuclear Regulatory Authority of the Republic of Armenia and The United States Nuclear Regulatory Commission on the Exchange of Technical Information and Cooperation in Nuclear Safety Matters was signed at Washington DC (approved by the President of Armenia on 02.05.2007 under the ordinance № 103-N).

Armenia is ready to cooperate with other countries on emergency planning related issues.

## **CHAPTER 4. SAFETY OF INSTALLATIONS**

### **4.1. Siting**

#### **ARTICLE 17. SITING**

*Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:*

- I. for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;*
- II. for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;*
- III. for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;*
- IV. for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.*

Detailed description of Armenian NPP site is provided in the previous national reports.

#### **4.1.1. Safety Acceptability of Armenian NPP, Taking Account of Site-Related Factors Change**

Seismic safety improvement measures were implemented in 2005-2007. Current status of seismic safety reevaluation program implementation is describes in Annex 7. Probabilistic seismic hazard analysis of Armenian NPP site has been developed for the probabilistic seismic input purposes. For the first time the British company “Aspinal” made integration of all existing tectonic models of the site and earthquake catalogues available in the Armenian research institutions. The Uniform Response Spectra for horizontal ground motion of Armenian NPP site has been defined. According to the obtained curves the seismic hazard re-evaluated earlier by deterministic analysis is well acceptable and value of peaking ground acceleration  $PGA=0,35g$  accepted as initial value for seismic safety upgrading program has been once again confirmed.

ENCONET carries out seismic PSA, which is planned to be completed in 2007.

#### **4.1.2. Evaluation of NPP Impact on Environment and Population**

Analysis of environmental monitoring results and evaluation of population exposure dose origination through food chain show that exposure dose incurred by population residing around

Armenian NNP was approximately 1  $\mu\text{Sv}/\text{year}$ , which is significantly lower the dose constrain of population from NPP (250  $\mu\text{Sv}/\text{year}$ ). As far as the low level of optimization of population dose constrain is accepted 20  $\mu\text{Sv}/\text{year}$ , when the stochastic effects hazard origination is  $10^{-6}/\text{year}$ , 1  $\mu\text{Sv}/\text{year}$  is well acceptable for population.

## 4.2. Design and Construction

### **ARTICLE 18. DESIGN AND CONSTRUCTION**

*Each Contracting Party shall take the appropriate steps to ensure that:*

- I. the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;*
- II. the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;*
- III. the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.*

Detailed information has been provided in the previous national reports.

## 4.3. Operation

### **ARTICLE 19. OPERATION**

*Each Contracting Party shall take the appropriate steps to ensure that:*

- I. the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;*
- II. operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;*
- III. operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;*
- IV. procedures are established for responding to anticipated operational occurrences and to accidents;*
- V. necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;*
- VI. incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;*
- VII. programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;*
- VIII. the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.*

### 4.3.1. Authorization of NPP Operation

The scope of all implemented safety improvement measures was revised in 2006. The modification plan for 2006-2016 has been complemented by new measures.

Based on complex safety analysis NPP modification program is planned to be revised. Results of currently developed PSA, SAR, deterministic safety analysis and operational safety enhancement will be taken into account in the complex analysis.

### 4.3.2. Safe Boundaries for Operation

Safe operation limits and conditions are specified in the Technical Specification for operation of Armenian NPP unit № 2 with WWER-440 (V-270).

### 4.3.3. Compliance of NPP Operation, Maintenance, Inspection and Testing with Approved Procedures

Armenian NPP unit № 2 is operated in accordance with the approved operational instructions developed based on “Technical specification for operation of Armenian NPP unit № 2 with WWER-440 (V-270)” and manufacturer specifications.

Maintenance, inspection and testing of nuclear installation are implemented in accordance with the approved programs and schedules developed based on requirements specified in the regulations.

### 4.3.4. Procedures for Responding to Anticipated Operational Occurrences and to Accidents

In accordance with the safety regulations Armenian NPP developed special emergency instructions that have been approved by ANRA. The instructions specify actions of personnel in management of nuclear installation at emergency situations at NPP.

Actions for organization of Armenian NPP personnel protection are specified in Armenian NPP emergency response plan (on-site emergency plan of NPP).

### 4.3.5. Engineering and Technical Support to NPP in all Safety-related Fields

Engineering and technical support to Armenian NPP in all safety-related fields is provided by organizations from Armenia, and also Russian Federation, United States of America , United Kingdom, European Commission and IAEA.

### 4.3.6. Reporting of Incidents Significant to Safety to Regulatory Body

The procedure on investigation and account for operational events has been developed with regard to recommendations specified in IAEA Safety Guide N93 “Systems for Reporting Unusual Events in Nuclear Power Plants” as of 1990 and the IAEA TECDOC-573 “The Analysis of Safety Important Events at NPP (ASSET)” as of 1990.

The procedure establishes the categories of operational events that should be evaluated by INES scale and also the criteria for reporting to regulatory body. The procedure also establishes the order of reporting to the regulatory authority of incidents important from safety point of view, and also form and contents of preliminary reports and investigation reports on incidents.

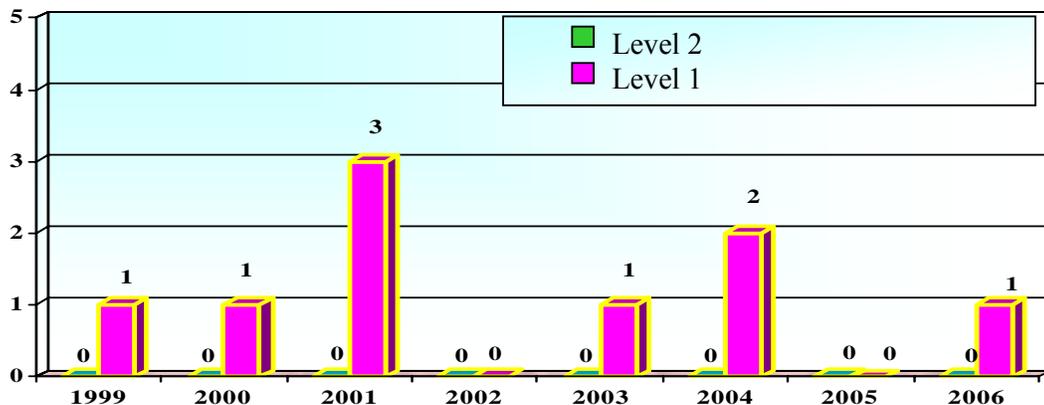


Figure 6. History of Safety Important Events of Armenian NPP Unit № 2 by INES Scale

#### **4.3.7. Organizing Collection and Analysis of Operating Experience, Use and Sharing of Analysis Results**

Armenian NPP collects and analyses information about operating experience. A database has been developed for processing and analysis of existing information. Armenian NPP actively cooperates with other NPPs and organizations operating similar units in sharing information. At the same time being a WANO member the Armenian NPP shares operating experience with other NPPs in frame of WANO such as operation indicators, peer review, notifications about occurred events.

ANRA is a member of WWER regulators Forum. Forum meetings are convened on annual basis with the purpose to exchange information on nuclear safety issues that are specific for WWER type reactors, present countries' reports about recent changes in the nuclear legislation, exchange information related to regulation of nuclear safety and atomic energy utilization, operational events of common interest and measures undertaken based on event investigation results.

## NATIONAL REGULATIONS AND LAWS

### International Treaties Ratified by Armenia

- Convention on Early Notification about Nuclear Accident ratified on 22.06.1993
- Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency ratified on 22.06.1993
- Vienna Convention on Civil Liability for Nuclear Damage ratified on 22.06.1993
- Convention on Physical Protection of a Nuclear Material ratified on 22.06.1993
- CTBT Comprehensive Nuclear-Test-Ban Treaty ratified on 21.12.1993
- Convention on Nuclear Safety ratified on 24.09.1997
- Treaty on the Non-Proliferation of Nuclear Weapons ratified on 24.09.1991
- Agreement between the Republic Armenia and the International Atomic Energy Agency for the Application of Safeguards in connection with Treaty on the Non-Proliferation of Nuclear Weapon signed on 23.09.1993
- Protocol Additional to the Agreement between the Republic Armenia and the International Atomic Energy Agency for “The Application of Safeguards in connection with Treaty on the Non-Proliferation of Nuclear Weapon ratified on 28.06.2004
- Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the International Atomic Energy Agency to the Government of the Republic of Armenia ratified on 04.06.2003

### Laws Adopted in Atomic Energy Utilization Field

- Law on Safe Utilization of Atomic Energy for Peaceful Purposes with amendments and supplements
- Law of the RA on Licensing (adopted 30.05.2001 NO-193 with supplements as of 16 March 2004 HO-52N)
- Code of the RA on Administrative Offences
- Law of the RA on Legal Acts (03.04.2002. HO-320N)
- Law of the RA on Civil Service (27.12.2001 HO-272)
- Law of the RA on Population Protection in case of Emergencies (02.12.1998 HO-265)
- Law of the RA on Organization and Conduct of Inspections (17.05.2000 HO-172)
- Criminal Code of the RA (18.04.2003)
- Law of the RA on Administration Principles and Procedure (18.02.2004 HO-41N)
- Law of the RA on Energy (07.03.2001 HO-148)

### Government Decrees Adopted in Atomic Energy Utilization Field

- Government Decree № 573 as of 13.11.1993 on establishment of the state authority under the government of the RA on regulation of nuclear and radiation safety for atomic energy utilization (Armenian Nuclear Regulatory Authority)

- Government Decree № 768 as of 22.12.1999 on approval of the list positions important in terms of safety in atomic energy utilization field
- Government Decree № 342 as of 25.04.2001 on establishment of the scientific and technical center on nuclear and radiation safety
- Government Decree № 640 as of 12.07.2001 on approval of the procedure for organization and conduct of safety expertise in the atomic energy utilization field
- Government Decree № 912-N as of 27 June 2002 on reorganization of ANRA
- Government Decree № 2013-N as of 21.11.2002 on approval of the requirements to form and contents of the Safety Analysis Report of the Armenian NPP Unit 2
- Government Decree № 2183-N as of 26.12.2002 on approval of the statute and structure of the state regulatory inspection for nuclear and radiation safety in atomic energy utilization (ANRA) of the administration of the ministry for nature protection of the Republic of Armenia
- Government Decree № 1953-N as of 30.10.2004 on preparedness to response to nuclear and radiation emergencies in the RA
- Government Decree № 1792-N as of 09.12. 2004 on approval of the procedure licensing and form of license for storage of radioactive materials, devices containing radioactive materials, or radiation generators
- Government Decree № 257-N as of 10.02. 2005 on approval of the licensing procedure and licence form for designing of systems, structures and components important to safety of atomic energy utilization object
- Government Decree № 258-N as of 10.02. 2005 on approval of the licensing procedure and licence form for manufacture of systems, structures and components important to safety of atomic energy utilization object
- Government Decree № 345-N as of 24.03.2005 on approval of the licensing procedure and licence form for expertise of atomic energy utilization objects, their designs and other documents
- Government Decree № 400-N as of 24.03. 2005 on approval of the licensing procedure and licence form for operation of nuclear installations
- Government Decree № 608-N as of 12.05. 2005 on approval of the licensing procedure and licence form for designing of nuclear installations
- Government Decree № 609-N as of 12.05. 2005 on approval of the licensing procedure and licence form for site selection of nuclear installations
- Government Decree № 649-N as of 12.05. 2005 on approval of the licensing procedure and licence form for construction of nuclear installations
- Government Decree № 707-N as of 01.06. 2005 on approval of the licensing procedure and licence form for decommissioning of nuclear installations
- Government Decree № 781-N as of 16.06. 2005 on approval of the licensing procedure and licence form for services and practices not foreseen in the original design implemented during site selection, designing, construction, commissioning, operation and decommissioning of nuclear installations
- Government Decree № 1858-N as of 14.12.2006 on approval of the licensing procedure and licence and application form and procedure for qualification check of physical persons holding positions important for safety in atomic energy utilization field
- Government Decree № 1489-N as of 18.08. 2005 on approval of radiation safety norms
- Government Decree № 1219-N as of 18.08. 2005 on approval of radiation safety rules
- Government Decree № 1637-N as of 16.10.2006 on opening a special account for

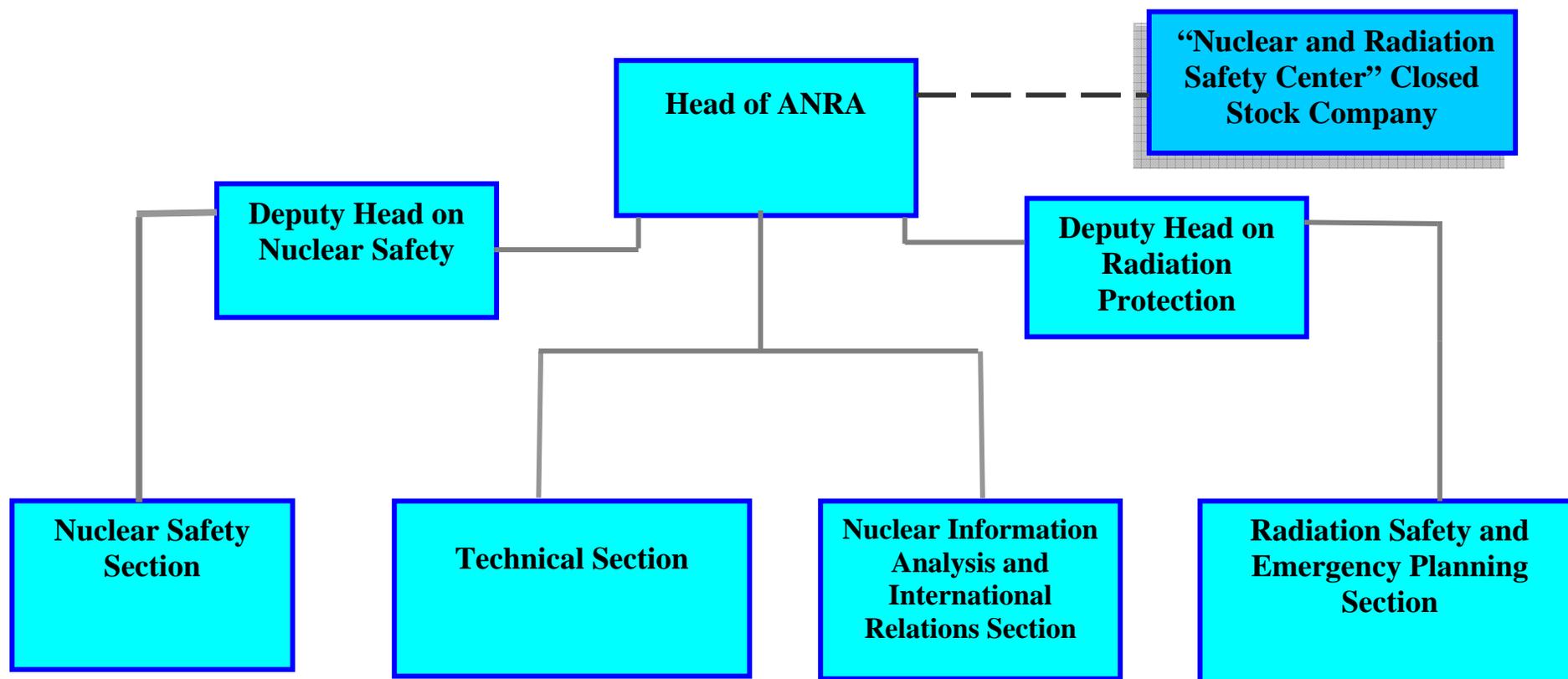
decommissioning of Armenian NPP

- Government Decree № 532-A as of 03.05.2007 on approval of composition of a commission on management of special account for decommissioning of Armenian NPP

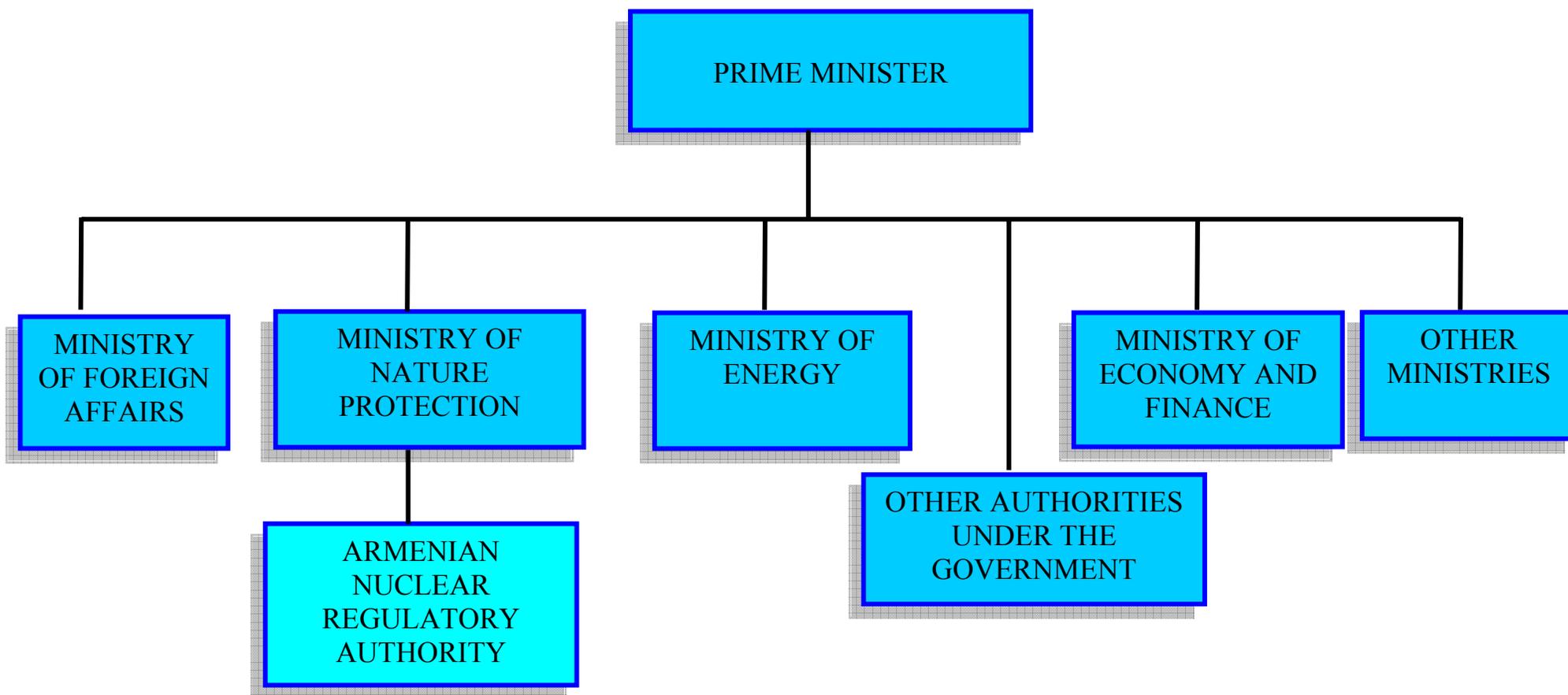
**Ministerial Acts Adopted in Atomic Energy Utilization Field**

- Requirements to form and content of expert conclusion on safety expertise in atomic energy utilization field
- Establishment of Armenian NPP emergency planning zones

## ORGANIZATIONAL CHART OF ANRA



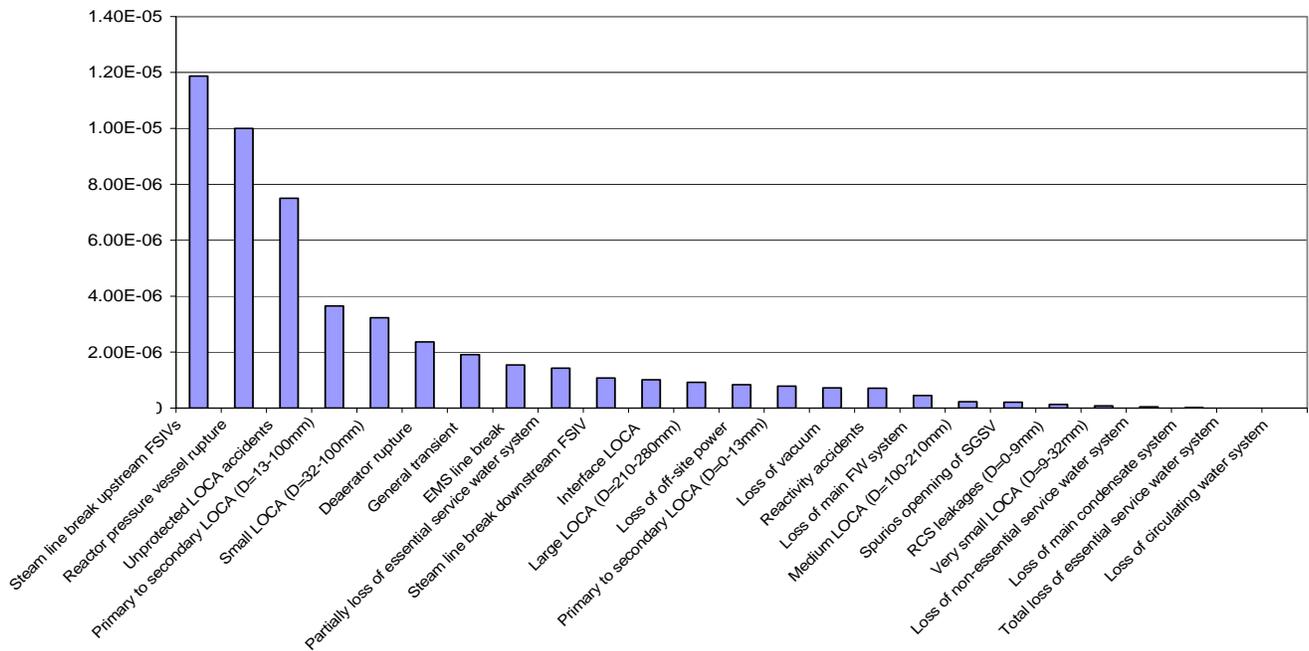
## STATUS OF ANRA WITHIN GOVERNMENT OF ARMENIA



**PSA Results**

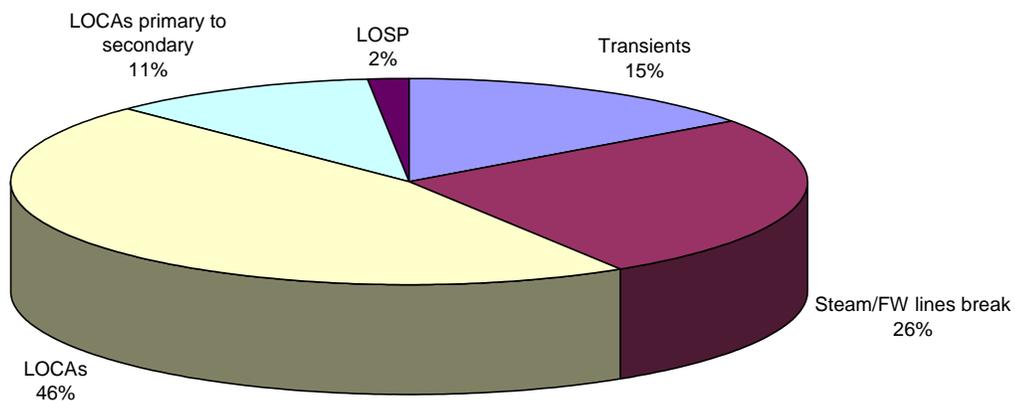
Quantification of PSA model was implemented in two stages. After implementation of tasks specified in PSA first stage of quantification was implemented to identify operator’s errors contributing most to the core damage. After detailed analysis of most important operator’s errors the final quantification PSA model has been made.

Final quantification of PSA model showed that the core damage frequency equals to 7.58E-05 1/year. The risk profile for Armenian NPP based of PSA Level I model analysis is shown on Figure 1.



**Figure 1. Armenian NPP Risk Profile**

Groups of initiating events were classified by analysis specific to certain accident originated from initiating event. Contribution to overall risk of core damage from groups of initiating events is provided on Figure 2. As it is shown, primary leaks are major contributors.



**Figure 2: Risk Contributor from Different Types of Initiator**

Based on obtained results the following recommendations on safety enhancement have been developed:

- Measures should be undertaken to prevent core damage at accidents with primary LOCA with equivalent diameter 500mm.
- Measures should be undertaken to decrease frequency of primary LOCA with equivalent diameter 500mm. This task can be partially solved by implementation of LBB concept at Armenian NPP.
- From the obtained results it becomes apparent that it is necessary to carry out detailed analysis of impact of make-up water pipeline break, deaerator or main steamlines on equipment of Armenian NPP turbine hall.
- Probabilistic structural analysis for reactor break to decrease conservatism of PSA model
- The obtained results show that primary leaks (including primary-to-secondary leaks) make more than 55% from total value of Armenian NPP core damage frequency and major contributors are minimum sections with failure in emergency primary make-up system, especially with failures of safety valves of emergency make-up pumps resulting in impossibility to supply water to primary side for leak compensation. Measures should be undertaken to increase reliability of primary emergency make-up water system.

On this stage more detailed study of results for determination latent safety deficiencies is made.

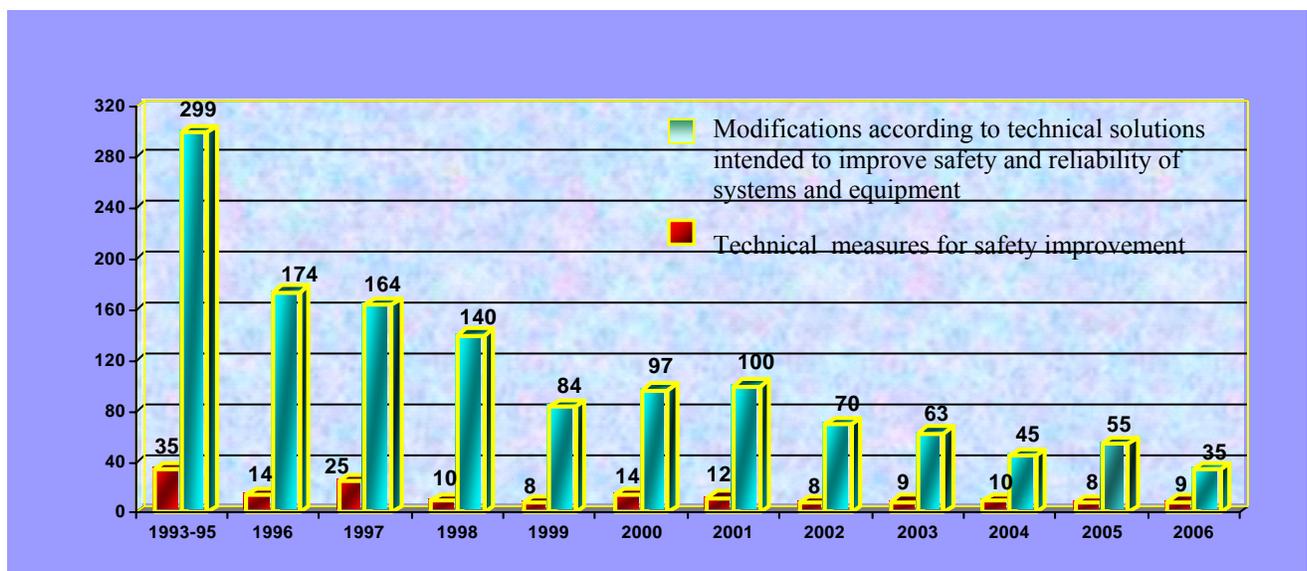
## Safety Improvements

The following safety improvement measures were implemented at Armenian NPP in 2004-2006:

- Installation of primary and secondary water chemistry control automatic system,
- Modernization of NPP dosimetric control system,
- Implementation of feed-and-bleed procedure,
- Completion of analysis for applicability of leak-before-break concept,
- Construction of premise of second channel safety systems for galvanic and physical separation of channels,
- Implementation of measures for bringing reactor in safe conditions after seismic impact,
- Installation of emergency water level control system in reactor,
- Replacement of switchers 0,4kV by more reliable ones,
- Replacement of main computer (New system provides with input of 1050 analog, 750 discrete parameters and output of 410 discrete signals, query period 0,1 sec (the replaced system didn't envisage archiving of information, query period was 9 sec),
- Replacement of 6kV oil breakers of II category auxiliaries uninterruptible power supply system with 6kV non-oil breakers,
- Clarification of mechanical properties of reactor vessel internal cladding with application of ABIT Method,
- Implementation of new software "Cascade" for core refueling calculation,
- Modernization of electrical circuit of low frequency converter of reactor protection control system,
- Replacement of aluminum cables by copper cables for electrical drivers of safety category 2 and 3 in reactor hall,
- Improvement of reliability and operability at pressure change signal activation in primary side and level in PRZ,
- Improvement of reliability of water pumping system from Unit № 2 boron unit sump,
- Installation of automatic spectrometric system for on-line control of discharges from sewerage system,
- Modernization of essential service water system,
- Improvement of reliability automatic scheme for maintaining hot standby of DG3-6 hot reserve,
- Modernization of source range monitoring system,
- Modernization of I category auxiliaries uninterruptible power supply system,
- Replacement of obsolete reversible motor generators –1,2,
- Modernization of automatic water level regulation system in SG,
- Modernization of reactor neutron flow control system,

- In-service inspection of primary pipeline and make-up water with application of modern equipment and methodologies,
- Modernization of physical protection system,
- Assessment of safety systems media in boron room and in other premises where temperature can abruptly change under impact of reviewed level of design accident,
- Seismic reevaluation of Armenian NPP unit № 2 with international experts,
- Development of qualification program for equipment important to safety in accordance with existing equipment qualification standards.

Besides above mentioned measures there have been implemented a significant number technical solutions aimed to improve safety and reliability of systems and equipment. Dynamic of implementation of safety improvement measures is provided below.



*Figure 3. Implementation of Safety Improvement Measures at Armenian NPP Unit № 2 in 1993-2006*

162 technical measures and 1326 modifications for safety and reliability improvement have been implemented since 1993.

**The following design safety improvement measures are planed for 2007-2008:**

- Modernization of DG rate, power, control regulation devices,
- Reconstruction of sequential start-up circuit,
- Modernization of reactor automatic power regulator,
- Physical separation of emergency power supply system into 2 channels with two operating diesels on each channel,
- Seismic walkdown,
- Installation of diagnostic systems based on results of applicability of LBB concept for Armenian NPP,

- Analysis of consequences at high energy pipes breaks of primary and secondary of sides close to safety systems and safety important systems,
- Reconstruction of spray system,
- Implementation of system for emergency gas removal from reactor cover.

The IAEA proposed to assist with coordination of international technical assistance to the Armenian NPP via discussions with countries rendering assistance in Armenian NPP safety improvement. Following the proposal in December 2005 in Vienna there was convened first technical meeting for coordination of international assistance to Armenian NPP with participation of representatives from Armenia (Ministry of Energy, ANRA, Armenian NPP), EC, IAEA, DOE, Czech Republic (NRI REZ) for exchange of information on current and planned safety improvement measures and for prioritization of improvements required for further safety enhancement of Armenian NPP unit № 2.

Taking into account the agreements reached during the meeting the list of technical safety improvement measures for Armenian NPP unit № 2 for 2006-2016 has been developed, agreed with ANRA and approved with the Ministry of Energy.

Further to first technical meeting on coordination of international assistance to Armenian NPP in October 2006 the Ministry of Energy organized the second technical meeting.

The next meeting is planned for IV quarter 2007, and will be mainly focused on progress with implementation of measures and with this regard revision and development of detailed schedule for implementation of each measure.

At the last coordination meeting there was reviewed the need for development of NPP modification program based on complex safety analysis.

Taking into account the experience of similar NPPs in development of complex safety analysis program the Armenian NPP commenced activities in this direction with involvement of experienced in this area experts.

Action plan for complex safety analysis has been developed. The plan consists of 2 main stages:

- Stage 1 – safety assessment,
- Stage 2 – review of safety assessment results.

Stage 1 – safety assessment envisages implementation of 3 separate in-depth safety assessments in parallel:

- Deterministic safety assessment,
- Probabilistic safety assessment,
- Operational safety assessment.

Upon completing in-depth safety assessment, review of the results should demonstrate impact and importance of any detected problems for maintaining relevant defense-in-depth protection.

Stage 2 – review of safety assessment results envisages:

- Strategic review of assessment results and development of a list of additional safety improvement measures,
- Assessment of feasibility of measures and development of schedule.

## Operational Safety Enhancement

Operational safety enhancement program of Armenian NPP was approved in 2005.

The program envisages improvements in 8 main areas of operational safety with implementation of modern international approaches.

The program includes 30 directions, for instance:

- Operation management,
- Maintenance and repair management,
- Configuration and modifications management,
- Radioactive waste management,
- Nuclear fuel management and so on.

The following documents are planned to be developed:

- More than 250 administrative and technical documents,
- More than 60 operational documents (programs, instructions for operation),
- Training materials on 26 subjects including different direction of operational safety,
- More than 50 technical documents for repair of valves, heat exchangers and pumps.

In September 2006 schedule for development of documents related operational safety enhancement has been developed and approved.

Progress of implementation of operational safety enhancement program was regularly discussed during “2+2” meetings with participation of ANRA and Riskaudit (GRS&IRSN) experts.

85 out of 195 measures included in the program have been implemented.

87 out of 110 measures left are on the stage of implementation. 23 measures of on the stage of planning and organization, i.e. approaches to solving problems are searched, information is studies, clarification of scope of activities.

Among the measures implemented in the reporting period it is note to mention:

- Measures for dissemination of safety policy and allocation of responsibilities for nuclear safety (making personnel aware of management declarations, clear definition of duties and responsibilities for nuclear safety),
- Measures for improvement of quality of marking and avoiding false identification (documents specifying requirements to identification and marking of systems and equipment, structures, devices, instruments have been developed),
- measures for improvement of operating documentation quality (technical specification, development of a set of operational procedures for normal operation),
- Measures for improvement of quality of emergency operating procedures (8 procedures have been developed),
- Measures for management of operational feedback control system (implementation of administrative and technical documentation).

The safety enhancement program emphasizes improvement of Armenian NPP emergency

preparedness. In particular:

- New in-plant emergency response procedures have been developed:
- Training of Armenian NPP personnel have been organized. Training of operating personnel has been organized in national training center of Armenian State Engineering University,
- Armenian NPP emergency center have been re-equipped.
- Emergency exercise for verification of key functions of Armenian NPP on-site plan is planned to be conducted.

Significant progress has been achieved in area of training and qualification of personnel. Decision has been made on establishment of modern training center based on existing training center.

This decision envisages constriction of training premise with training classes, laboratories and workshops equipped with equipment, relevant technical and educational and methodological literature. Assessment of the whole personnel training process for compliance with modern requirements to personnel training has been made. Plan for improvement of NPP personnel training system for 2006-2008 has been developed.

The plan envisages a set of tasks on:

- Development and implementation of administrative procedures (guides, instructions), specifying and regulating training process,
- Training of instructors and trainers from NPP divisions for planning, methodology training and development of training-reporting documentation,
- Development of initial personnel training program (including training materials) by SAT methodology. There have been selected 32 positions for which there will be developed standard training programs and materials on SAT methodology. In accordance with the schedule the whole set of programs and training materials is planned to be developed till the end of 2008.

A set comprising of 21 administrative and methodological training guidelines have been developed. Construction of new training center is on the stage of completion.

Standard training programs (including training materials) on SAT methodology for 7 positions of operating personnel have been developed.

Discussion of progress of implementation of operational safety enhancement program together with other issues was included in the agenda of technical meeting on coordination of international assistance to Armenian NPP in Vienna in December 2005. At the recommendation of technical meeting in March 2006 the coordination meeting took place at the Armenian NPP on operational safety enhancement related issues with participation of representatives of IAEA, EC, DOE. During the meeting approaches to implementation of planned measures, coordination of actions and international assistance were discussed.

In parallel with implementation of wide range of measures included in the operational safety enhancement program Armenian NPP makes preparations to the OSART mission planned for 2009.

Seismic Safety

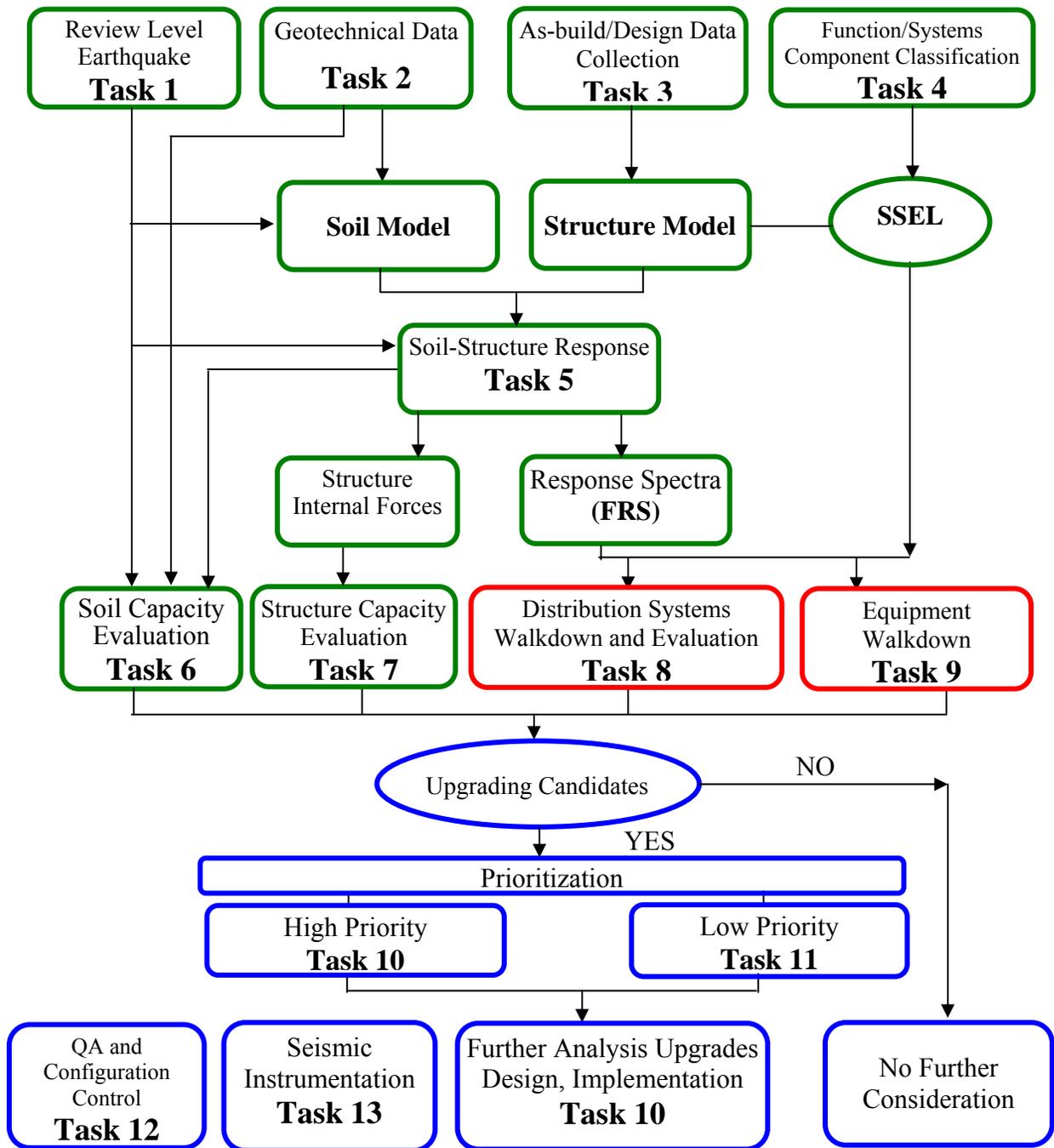


Figure 4. Flowchart of Seismic Safety Reevaluation Program, Implementation Status

Legend: Completed tasks Outage-2007... To be completed

## LIST OF ABBREVIATIONS

ABIT	Methodology of Non-Destructive Testing
ALARA	As Low As Reasonable Achievable
ANL	Argon National Laboratory
ANRA	Armenian Nuclear Regulatory Authority
Armenian NPP	Armenian Nuclear Power Plant
Armatom	Scientific and Research Institute
Atomservice	TSO of Armenian NPP
ASSET	Assessment of Safety Significant Events Team
DG	Diesel Generator
DOE	Department of Energy of USA
FRS	Floor Response Spectra
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit
IAEA	International Atomic Energy Agency
IPSART	International Probabilistic Safety Analysis Review Team
INES	International Nuclear Events Scale
IRSN	Institut de Radioprotection et de Sûreté Nucléaire
I&C	Instrumentation and Control
LBB	Leak-before-Break
NRSC	Nuclear and Radiation Safety Center
OSART	Operational Safety Analysis Review Team
PGA	Peak Ground Acceleration
PSA	Probabilistic Safety Analysis
PRZ	Pressurizer
SAR	Safety Analysis Report
SAT	Systematic Approach to Training
SG	Steam Generator
SSC	Systems, Structures, Components
SSEL	Safe Shutdown Equipment List
TSO	Technical Support Organization
WANO	World Association of Nuclear Operators