ROMANIA

National Report under the Convention on Nuclear Safety

8th Revision, August 2019

FOREWORD

This report demonstrates how Romania has fulfilled its obligations under the Convention on Nuclear Safety.

The structure of the 8th national report is similar to that of the reports previously submitted by Romania and follows the guidelines of INFCIRC/572/Rev.6. The information provided in the previous reports has been further detailed and updated, highlighting, where necessary, the most significant developments since the elaboration of the 7th national report.

This report has been prepared by the National Commission for Nuclear Activities Control, in consultation with and incorporating contributions from the National Company Nuclearelectrica.

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INTRODUCTION

1. Current role of nuclear power in Romania

The nuclear policy of Romania encompasses the development and use of nuclear energy and other nuclear fuel cycle activities in Romania as well as oversight of the development and enforcement of nuclear legislation and regulations to ensure that all nuclear activities are strictly regulated and controlled to the highest standards to ensure public health and safety.

Romania has only one nuclear power plant, Cernavoda NPP, with two units in operation. Cernavoda NPP Units 1 and 2 cover approximately 18% of Romania's total energy production. The Government has plans to further increase nuclear generating capacity through the commissioning of Units 3 and 4 of the Cernavoda NPP. The decision to complete Units 3 and 4 was taken in June 2007. Pre-licensing reviews have been successfully completed, but no application for a construction license has been submitted yet. The construction of Unit 5 has been cancelled by a decision of the General Shareholder Assembly of the National Company Nuclearelectrica, the owner and operator of Cernavoda NPP. The existing structures of Unit 5 will be used for different activities connected to the operation of Units 1 and 2 and, in the future, of Units 3 and 4.

Table 1. List of Romanian nuclear installations

Reactor	Type	Gross Capacity MW(e)	Construction Start	First Criticality	Operating Status
Cernavoda-1	CANDU-6	706.5	1980	16th of April 1996	in operation
Cemavoda-2	CANDU-6	706.5	1980	6th of May 2007	in operation
Cemavoda-3	CANDU-6	720	1980	-	under preservation, plans for resuming construction
Cemavoda-4	CANDU-6	720	1980	-	under preservation, plans for resuming construction
Cemavoda-5	CANDU-6	-	1980	-	no plans for resuming construction; the existing structures will be used for supporting activities of the other units.

Long term commitment to nuclear power development, considered one of the drivers of the Energy Strategy of Romania, builds on the well-developed national nuclear infrastructure, proven and safe technology and excellent performance of Cernavoda NPP, as well as on the positive public perception of the nuclear energy.

2. Main Governmental Organizations with responsibilities in the nuclear sector

The Ministry of Energy establishes the national strategy in the energy field and is the major shareholder of the nuclear energy production sector, nuclear research and engineering, nuclear fuel and heavy water production.

The National Commission for Nuclear Activities Control (CNCAN) is the nuclear safety and security regulatory authority of Romania, responsible for the regulation, licensing and control of nuclear activities, ensuring the peaceful use of nuclear energy and the protection of public and workers from the harmful effects of ionizing radiation. CNCAN elaborates the strategy and the policies for regulation, licensing and control with regard to nuclear safety, radiological safety, non-proliferation of nuclear weapons, physical protection of nuclear installations and materials, transport of radioactive materials and safe management of radioactive waste and spent fuel, as part of the national strategy for the development of the nuclear sector. CNCAN reports to the Prime Minister, through the General Secretary of the Government.

The Ministry of Environment is the central authority for environmental protection and has specific responsibilities in this domain in the licensing and control of nuclear installations.

The State Inspectorate for Boilers, Pressure Vessels and Hoisting Installations (ISCIR), subordinated to the Ministry of Economy is responsible for the licensing and control of the pressure systems and equipment, including those used in nuclear installations, with appropriate consultation and collaboration with CNCAN.

The Nuclear Agency and for Radioactive Waste (AN&DR), subordinated to the Ministry of Economy, is responsible for promoting the peaceful use of nuclear energy and the related research and development programs and for the coordination, at national level, of the safe administration process of spent nuclear fuel and of radioactive wastes, including their disposal.

3. Main companies in the Romanian nuclear power industry

The National Company "Nuclearelectrica" SA (Societatea Nationala Nuclearelectrica SA, further referred to in this report as SNN) is the owner and operator of Cernavoda NPP. The company includes two subsidiaries, no legal persons, one for nuclear power production (Cernavoda NPP) and one for nuclear fuel production (Nuclear Fuel Plant - FCN Pitesti), respectively. SNN is a government owned company, subordinated to the Ministry of Energy.

The company was listed on the Bucharest Stock Exchange in 2013 and, in its current shareholding structure, the Romanian state, through the Ministry of Energy, owns approximately 82.5 percent of the shares. The remaining percentage is owned by investment funds and other shareholders.

There are two national research and engineering institutes in the nuclear field - the Institute for Nuclear Research (ICN - Pitesti), which operates a TRIGA research reactor, and the Centre for Nuclear Projects Engineering (SITON - Bucharest). These two organizations are subsidiaries of the state owned company “Technologies for Nuclear Energy” (RATEN) which was established in 2013, by separation from the state-owned RAAN. RATEN is in charge of research and engineering activities devoted to the national nuclear power program. The two organizations are acting as scientific, technical and engineering support (technical support organizations) for the safe operation of Cernavoda NPP and for the other installations and projects that are part of the national nuclear power program.

The National Company for Uranium (CNU), also government owned and subordinated to the Ministry of Energy, is responsible for the administration of the national uranium mineral resources and performs geological research and exploitation activities for uranium ores, ores processing and concentrates refining, their transport and marketing.

Fig. 1.1 Location of nuclear installations and associated facilities

4. Main themes and safety issues presented in the report

The present report can be summarised as follows:

- Changes to the regulatory framework, taking account of the development of international safety standards and recognised good practices;
- Safety improvements implemented or planned by the license holder for Cernavoda NPP;
- Implementation of the principles of the Vienna Declaration on Nuclear Safety.

SUMMARY

1. Summary of challenges, good practices, noteworthy items and suggestions for Romania from the 7th CNS Review Meeting

The results of the peer review of the National Report of Romania are summarized below:

1.1. Challenges

Challenge 1: Romania should increase qualified staff to ensure the regulator can sustain the delivery of its regulatory mandate and to provide the regulator with sufficient resources.

Actions taken in response to Challenge 1: In September 2018, the organizational structure of CNCAN has been modified to increase the number of staff. Several recruitment campaigns have been conducted and additional staff was hired. A formalized training and qualification program for nuclear inspectors has been implemented starting with 2016. International technical cooperation programs have continued to be used for strengthening the regulatory competences. These actions are described in the chapter corresponding to Article 8. However, efforts are still ongoing to staff all the available positions with personnel having adequate educational background, experience and qualifications and to improve staff retention. This remains a challenge.

Challenge 2: Further developing the regulatory competences, in particular by:

- developing in-house expertise for performing independent safety analyses;
- enhancement of regulatory expertise in the assessment of human factors;
- effective implementation of the Safety Culture Oversight Program.

Actions taken in response to Challenge 2: More training has been organized for CNCAN staff, with assistance from international partners, for the development of in-house expertise in safety analyses, in the assessment of human factors and in the implementation of the safety culture oversight program. These actions are described in the chapter corresponding to Article 8.

As described in the chapter corresponding to Article 7, in the Section 7.7 on regulatory developments for the last reporting period, new regulations and regulatory guides have been issued which further support the regulatory oversight in the area of nuclear safety analyses, human factors and safety culture.

Challenge 3: Finalizing the implementation of recommendations resulting from the last IRRS Mission to CNCAN (January 2011).

Actions taken in response to Challenge 3: In October 2017, CNCAN received a follow-up IRRS. The IRRS team found that Romania had systematically addressed the findings made by the previous mission, implementing most of its recommendations and addressing the lessons learned from the 2011 Fukushima Daiichi accident. The follow-up IRRS report has been made public on the IAEA website: https://www.iaea.org/sites/default/files/documents/review-missions/irrs_follow-up_mission_rep_romania_2017.pdf .

The IRRS team noted that significant progress has been made in many areas. Specifically, 30 out of 34 recommendations and all 18 suggestions were closed. During the follow-up mission, the IRRS team developed 8 new recommendations and 4 new suggestions.

Also, the IRRS team noted that the Romanian Government showed a strong commitment to nuclear safety and improvement of regulatory control of the nuclear sector including;

- Approval of the National Strategy on Nuclear Safety and Security (NSNSS);
- Advanced the revision of the national strategy for radioactive waste and nuclear spent fuel management;
- Significant progress in the amendment of the Law 111/1996 to implement the BSS Directive;
- Commitment to ensuring an appropriate level of human resources to CNCAN when the Law 111 has been amended;
- Plans to significantly increase the CNCAN operational budget starting at the 2018 state fiscal year.

In several areas of regulatory responsibility, CNCAN has made significant progress from the previous IRRS mission. The IRRS team highlighted the following:

- Initiated, led or coordinated many initiatives related to the NSNSS;
- Progressed the implementation of the graded approach throughout its programs;
- Continued to develop regulations and guidance for authorizations, and internal procedures for review, assessment, and inspections;
- Advanced its capabilities to respond to nuclear and radiological emergencies;
- Adequately addressed the TEPCO Fukushima Daiichi response plan.

The IRRS team also noted that in spite of all the improvement work carried out by CNCAN, many tasks were not completed due to resource constraints. It was expected that the actions initiated by the Government to increase resources for CNCAN, will support the prompt completion of these tasks.

As already mentioned above in response to Challenge 1, the organizational structure of CNCAN was modified in 2018 to allow for the increase in staffing. Several recruitment campaigns have been conducted and additional staff was hired. However, efforts are still ongoing to staff all the available positions with personnel having adequate educational background, experience and qualifications and to improve staff retention.

1.2. Suggestions

Suggestion 1: Finalizing the implementation of the new seismically qualified on-site emergency control centre and the firefighters facility.

Response to Suggestion 1: Work is in progress at Cernavoda NPP for establishing a new seismically qualified location for the on-site emergency control centre and the fire fighters. The estimated date for the completion of this new centre is the end of 2020. This location will include important intervention equipment (mobile diesel generators, mobile diesel engine pumps, fire-fighter engines, radiological emergency vehicles, heavy equipment to unblock roads, etc.) and will be protected against all external hazards. The target date for the completion of this new centre was initially set for the end of 2015. The completion date was changed due to legal and administrative issues related to transfer of property of the physical location. Until the completion of this action, equivalent measures have been implemented to ensure that all intervention equipment (mobile Diesels, Diesel fire pump, fire trucks, and so) are protected from external hazards (e.g. the equipment have been relocated so that they would not be impaired by external events).

Suggestion 2: Add annual financial budget of CNCAN for several years in a summary table in the national report.

Response to Suggestion 2: The annual financial budget of CNCAN, for several years, has been presented in a summary table included in the chapter corresponding to Article 8, Section 8.3.

Suggestion 3: Provide a strategy for maintaining sufficient qualified staff for all nuclear safety related activities, on a long-term at national level.

Response to suggestion 3: Directions for action are already provided in the National Strategy on Nuclear Safety and Security (NSNSS). In order to support the implementation of the provisions of this strategy and to facilitate the requirements in the legislation for providing sufficient human resources for all nuclear safety related activities, CNCAN has issued more specific requirements in regulation NSN-21 - Fundamental nuclear safety requirements for nuclear installations (2017). The licensees are required to prepare long-term staffing plans to ensure sufficient qualified personnel, with the necessary competences, for all activities important to nuclear safety, for a period of at least 10 years. These staffing plans need to be reviewed at least every 3 years and updated as necessary to cover the entire lifetime of the nuclear installations. The staffing plans are required to take account of ageing of the workforce, staff turnover and of the necessary time for recruiting and training new staff. The licensees are required to ensure that their staffing plans provide adequate margins, in order to have at all times sufficient qualified staff for all activities important to nuclear safety.

1.3. Good Practices and Areas of Good Performance

During the peer review of Romania's National Report at the 7th CNS Review Meeting, the Contracting Parties were invited to recommend Good Practices and to highlight Area of Good Performance. No good practices were identified for Romania. The following Area of Good Performance of Romania were commended by the Country Group:

- Area of Good Performance 1: Intense international cooperation of the operator in the framework of the CANDU user group.
- Area of Good Performance 2: Openness to receiving peer-review missions on a frequent basis.
- Area of Good Performance 3: Implementation of a safety culture oversight program.
- Area of Good Performance 4: Encouraging the initiation of Abnormal Condition Reports (ACRs) for low-level events and near-misses; extensive use of operational experience feedback to improve safety performance.
- Area of Good Performance 5: Human performance training courses (classroom, practical training courses and Dynamic Learning Activities) have been extended with new courses, especially regarding practical human performance skills, in order to train plant personnel on human performance best practices and Event Free Tools.
- Area of Good Performance 6: Intense international cooperation of the regulator.

2. Significant developments for the last reporting period

The most significant developments for the last reporting period are presented in dedicated sections of the chapters corresponding to:

Article 7 - New regulations and regulatory guides have been issued by CNCAN. Details are provided in section 7.7.

Article 8 – The significant regulatory developments are summarized in section 8.9.

Article 10 - Developments are presented on both the regulator's and the licensee's side with regard to the assessment and improvement of nuclear safety culture. Details are provided in section 10.3.

Article 11 - The developments regard the improvements in the training programs and facilities for Cernavoda NPP personnel and the improvement of the regulatory framework. Details are provided in section 11.7

Article 12 - Details on the developments related to the licensee’s human performance improvement program are provided in section 12.9.

Article 13 - The developments are related to the improvement of the integrated management system of Cernavoda NPP. A summary of these developments is provided in section 13.8.

Article 14 - The main developments are summarized in section 14.6.

Article 15 - The main developments are outlined in section 15.3.

Article 16 - The main developments in the area of emergency preparedness are summarized in section 16.5.

Article 17 - The main developments are summarized in section 17.6.

Article 18 – The main developments, represented by design upgrades implemented in the last reporting period, are outlined in section 18.7.

Article 19 - The main developments are presented in section 19.9.

3. Implementation of the principles of the Vienna Declaration on Nuclear Safety

In February 2015, the Contracting Parties to the Convention on Nuclear Safety have adopted the following principles to guide them, as appropriate, in the implementation of the objective of the CNS to prevent accidents with radiological consequences and mitigate such consequences should they occur:

1. New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off site contamination and avoiding early radioactive releases or radioactive releases large

enough to require long-term protective measures and actions.

2. Comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.

3. National requirements and regulations for addressing this objective throughout the lifetime of nuclear power plants are to take into account the relevant IAEA Safety Standards and, as appropriate, other good practices as identified inter alia in the Review Meetings of the CNS.

The safety principles outlined in the Vienna declaration are implemented in Romania as follows:

Safety upgrades for increased protection against severe accidents have been implemented in Cernavoda NPP. These include:

- Passive autocatalytic hydrogen recombiners;
- Water make-up to ensure in-vessel core cooling;
- Filtered containment venting system to preserve containment function;
- Mobile diesel generators to ensure the power supply in case of station blackout;
- Improved instrumentation for monitoring safety parameters in severe accident situations.

Details on the safety upgrades are provided in the chapter corresponding to Article 18, Section 18.6 and in Annex 2. Operational improvements are presented in the chapter corresponding to Article 19.

Safety goals currently in use in Romania include:

- Dose-frequency criteria (maximum doses allowed for accidents of specified frequencies and / or maximum frequency allowed for accidents leading to doses in a certain range); these are established in the regulation on design and construction of NPPs (NSN-02);
- CDF (Core Damage Frequency) and LERF (Large Early Release Frequency) values based on INSAG-12; these are not formalized in regulations, but are used in review and assessment for licensing purposes, in accordance with the principles outlined in paragraph 27 of INSAG-12.
- New quantitative nuclear safety objectives established in the regulation NSN-21 (issued in 2017) and regulatory guide GSN-03 (issued in 2018), presented as follows.

The regulation NSN-21 - Fundamental nuclear safety requirements for nuclear installations and the regulatory guide GSN-03 - Guide on fulfilling the overall nuclear safety objective set in the fundamental nuclear safety requirements for nuclear installations provide new safety goals.

The regulation NSN-21, includes the following requirements:

"*Art. 4. – (1) The general nuclear safety objective that shall be observed in the design, siting, construction, commissioning, operation and decommissioning of a nuclear installation is to reduce at the minimum the risks associated with the exposure to ionizing radiation for the personnel, population and the environment.*

(2) The license holder, respectively the applicant for a license, shall take all the reasonable measures possible from technical point of view and practicable for the prevention of events which may lead to the exposure of the personnel, of the population and of the environment in excess of the limits established in the legislation. Also, all the reasonable measures, possible from technical point of view and practicable shall be taken for the limitation of the consequences of nuclear accidents, for the situations where such events may occur.

(3) For the purpose of fulfilling the general nuclear safety objective, the nuclear installations shall be designed, sited, constructed, commissioned, operated and decommissioned with the objective of preventing accidents and, should an accident occur, mitigating its consequences and avoiding:

a) early radioactive releases that would require off-site emergency measures without sufficient time to implement them;

b) large radioactive releases that would require protective measures that could not be limited in area or time.

(4) The requirements established in paragraph (3) apply to nuclear installations at their first license for the phases of design, siting, construction and installation.

(5) The requirements established in paragraph (3) shall be used as a reference for the timely implementation of reasonably practicable safety improvements to nuclear installations already existing at the time of the entering into force of this regulation, including in the framework of their periodic safety review."

The regulatory guide GSN-03, issued at the end of 2018 for facilitating the understanding and application of the requirements in article 4 of the regulation NSN-21, recommends the use of the following quantitative nuclear safety objectives:

a) Frequency of releasing into the environment a quantity of radioactive material that would require the temporary evacuation of the population from the vicinity of the nuclear site, quantified as the sum of the frequencies of all accident sequences with the source term higher than 1000 TBq of Iodine-131, to be less than 1E-5 / year. This quantitative objective aims at avoiding early releases of radioactive materials, which would require off-site emergency response measures without sufficient time to implement them. For accident sequences for which the source terms exceed 1000 TBq of Iodine-131, it should be demonstrated that the emission of radioactive material cannot occur in such a short time that it does not allow the population to be evacuated from the vicinity of the site.

b) Frequency of releasing into the environment a quantity of radioactive material that would require relocation of the population near the site, quantified as the sum of the frequencies of all accident sequences with the source term higher than 100 TBq of Cesium-137, to be less than 1E-6 / year. This quantitative objective aims at avoiding large releases of radioactive materials which would require protection measures that cannot be limited in space or time.

c) The cumulative frequency of all accident sequences that can lead to effective doses higher than 100 mSv in the first 7 days, for which the population in the vicinity of the nuclear facility is required to be evacuated in accordance with the generic criteria of the Regulation of Emergency Situations Management for nuclear or radiologic risk, to be less than 1E-5 / year.

d) The cumulative frequency of all accident sequences that can lead to effective doses higher than 100 mSv in the first year, for which temporary relocation of the population located near *the site is required according to the generic criteria of the Regulation of Emergency Situations Management for nuclear or radiologic risk, to be less than 1E-6 / year.*

In order to assess the fulfillment of the quantitative nuclear safety objectives, deterministic and probabilistic nuclear safety assessments have to be further developed and revised, in accordance with the requirements and recommendations in the applicable CNCAN regulations, regulatory guides and internationally recognized standards and best practices. The analyses shall cover all operational modes of the nuclear installation and shall take into account all internal and external initiating events relevant to the installation and to site. Both design basis accidents as well as the design extension conditions, including severe accidents, will have to be considered in the analyses. Accident scenarios affecting several nuclear installations located on a common site shall also be considered.

New regulations have been issued that take account of the lessons learned from the Fukushima Daiichi accident. These are presented in the chapter corresponding to Article 7, in the Sections 7.6 and 7.7.

CNCAN has issued in 2017 a regulation (NSN-21) for transposing the Council Directive 2014/87EURATOM of 8 July 2014 amending Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations, which has a similar nuclear safety objective for nuclear installations, mentioned above in relation to Safety Goals. The revision and updating of nuclear safety regulations is a continuous activity and efforts are made to align the provisions of the national regulatory documents with the latest standards issued by the IAEA.

Periodic safety reviews are performed in accordance with a national mandatory regulation which is based on the IAEA safety standards and WENRA reference levels and which takes account of the international good practices in this area. Opportunities for improvement, including plant upgrades, are identified based on the review against the latest standards and implemented. In addition, safety reassessments, including new or revised safety analyses, are performed every time new information becomes available, from operational experience or from research activities, which is significant in relation to the prevention and / or mitigation of nuclear power plant accidents, including severe accidents.

Details on the safety review and assessment process, including on periodic safety reviews, are provided in the chapter corresponding to Article 14. Details on the safety reviews of the protection against external events, conducted post-Fukushima, are provided in the chapter corresponding to Article 17.

The actions taken by CNCAN and Cernavoda NPP to take account of the lessons learned from the Fukushima accident have been presented in detail in public reports:

- National Report of Romania for the 2nd Extraordinary Meeting under the Convention on Nuclear Safety (May 2012) http://www.cncan.ro/assets/Informatii-Publice/06-Rapoarte/RO-National-Report-for-2nd-Extraordinary-Meeting-under-CNS-May2012-doc.pdf ;
- Reports on the implementation of the European “stress tests” by Romania: http://www.ensreg.eu/EU-Stress-Tests/Country-Specific-Reports/EU-Member-States/Romania .

The national action plan developed for bringing together the actions identified from regulatory reviews, self-assessments, peer-reviews and generic recommendations at international level is provided in Annex 2 of this report, presenting the current status of the main actions.

CNCAN monitors the licensee's progress in the implementation of the planned improvements and continues to perform safety reviews and inspections to ensure that all the opportunities for improvement are properly addressed taking account of the lessons learned from the Fukushima accident.

The IRRS team that performed a follow-up review in Romania in October 2017 has also assessed the actions taken by CNCAN and considered that the TEPCO Fukushima Daiichi accident implications were adequately addressed in the regulatory activities.

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.

6.1 General Remarks

As presented in the introduction, a total of five nuclear power reactors were intended to be built in Romania on Cernavoda site. Unit 1 was first to be placed in service in 1996, while Unit 2 was commissioned and started commercial operation in 2007. The construction of the other three units on the site was stopped at different stages, and these units are currently under preservation. All units are pressurized heavy water reactors (PHWR), CANDU 6 type.

Romania has ratified the Convention on Nuclear Safety through the Law no. 43 / 24 May 1995. The reviews required under Article 6 of the Convention have been assimilated to the normal licensing process, as Unit 1 of Cernavoda NPP was commissioned between the years 1993 and 1996 and work on Unit 2 restarted in 2001.

The previous national reports under the Convention have included comprehensive information on the historical development of the Cernavoda NPP project and on the safety reviews performed. Therefore, the information previously presented has been further updated by this report and is provided under the relevant articles (mainly under Articles 14, 17, 18 and 19).

The significant developments for the last report period have been presented in the Summary and are further detailed in the chapters corresponding to the relevant Convention articles.

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 license;
iii. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;
iv. the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.

7.1 Overview of the legislative and regulatory framework governing the safety of nuclear installations

The Law no. 111/1996 on the safe deployment, regulation, licensing and control of nuclear activities, republished with subsequent modifications and completions, provides the legislative framework governing the safety of nuclear installations. In this report, it will be further referred to as “the Law”.

The Law empowers the National Commission for Nuclear Activities Control (CNCAN), which is the national nuclear regulatory authority, to issue mandatory regulations, to issue licenses for nuclear installations and activities, to perform assessments and inspections to verify compliance with the nuclear safety requirements and to take any necessary enforcement actions. The structure and content of the Law are described in Annex 1.

7.2 Development of regulations

CNCAN is empowered by Law to develop regulations in order to detail the general legal requirements as well as any other regulations necessary to support the licensing and control activities.

CNCAN develops regulations in accordance with the Law 24/2000, on “Legislative technique for elaboration of the normative acts” and the Governmental Decision HG 561/2009 on the approval of the Regulation regarding the procedures for elaboration of public policy documents, which establish the general provisions, technical rules and administrative procedures for the development of all Romanian regulations (normative acts).

All the regulations issued by CNCAN are mandatory and enforceable. The regulations are developed in observance of relevant international standards and good practices.

The Management System of CNCAN includes a procedure for drafting regulations and a process is in place to ensure internal consultation among CNCAN departments regarding the draft regulations. This is undertaken prior to the external consultation. The aim of the internal review is to provide an independent assessment of the scope, structure, content and implications of the regulatory documents, by persons not directly involved in their production. In some cases, external experts are also involved in the review the draft regulations developed by CNCAN staff. The correctness with regard to technical and legal aspects is observed.

The regulations in draft are published on the CNCAN website and are sent for external consultation to all interested organizations in order to receive feedback. The comments and suggestions received are analyzed and discussed in common meetings. As a consequence of this review process, the regulations may suffer some amendments. Subsequently, the final revision of a regulation is approved by the President of CNCAN and then submitted for publication in the Official Journal of Romania. Besides publication in the Official Journal, in order to provide for broader dissemination, CNCAN publishes the regulations on its website.

In accordance with the provisions of the Law, CNCAN has the responsibility for reviewing the regulations whenever it is necessary for these to be consistent with international standards and with relevant international legislation in the domain, and for establishing the measures for the application thereof.

Various sources of information relevant for updating the system of regulations and guides are used, including the development of international legislation and safety standards, international cooperation, feedback from the industry and feedback from CNCAN inspectors based on their experience with the enforcement of the regulations, the results of research and development activities.

Besides the needs arisen from the licensing process, priorities for development of regulations were established as part of the harmonization process in the WENRA (Western European Nuclear Regulators' Association) countries.

7.3 Overview of the licensing system

The licensing practice for Cernavoda NPP is based on the provisions of the Law and of the regulations issued by CNCAN. The Law clearly stipulates that the prime responsibility for the safety of a nuclear power plant rests with the license holder. As required by the Law and by the regulations in force, a license is needed for each of the stages of the life time of a nuclear installation. For a nuclear power plant, the licensing stages include design, siting, construction, commissioning, operation and decommissioning. The licensing requirements and licensing process are established in the Regulation on the licensing of the nuclear installations (NSN-22).

This section only gives general information on the licensing process, the more detailed aspects being addressed in the chapters corresponding to the Articles 11 - 19.

The detailed regulatory requirements, as well as the assessment and inspection criteria used by CNCAN in the licensing process are derived from a number of sources, such as:

- Romanian regulations;
- Limits and Conditions specified in the different licenses;
- Regulatory guides;
- IAEA Safety Standards and Guides;
- ICRP recommendations;
- Applicable Standards and Codes (CSA, ANSI, ASME, IEEE, etc.);
- Safety related documentation produced by the licensee and approved or accepted by CNCAN (e.g. Safety Analysis Reports, Safety Design Guides, Design Manuals, reference documents, station instructions, operating manuals, technical basis documents).

Apart from the formally issued (published) regulations, the requirements established by CNCAN in the licensing process are imposed through regulatory letters. Requirements and dispositions are stated also in the inspection reports. In order to facilitate the implementation of the requirements established in the regulations, CNCAN issues regulatory guides on various topics.

Control of licensing submissions is described in the Management System of CNCAN, within the framework of which a set of procedures have been established that define the different activities and tasks performed by the different organizational divisions involved in the licensing process. The licensing process is outlined in the Regulation on the licensing of the nuclear installations (NSN-22) and is documented according to CNCAN internal procedures.

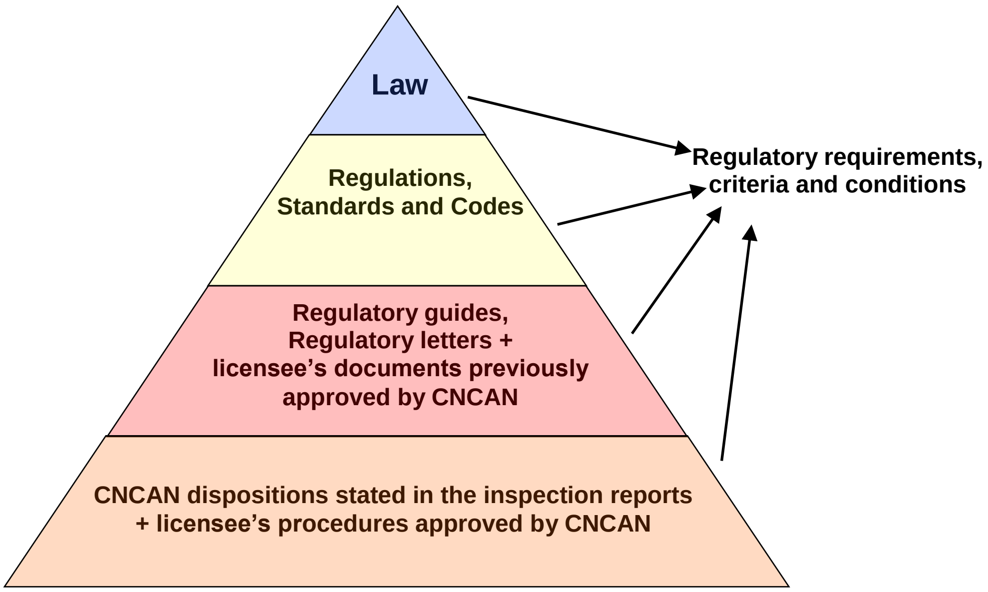


Fig. 7.1 - Documents containing requirements used by CNCAN in the licensing

The licensing submissions include, as the main document, a safety analysis report in accordance with the specifications established by CNCAN for each stage of the licensing process. The standard format and content for the safety analysis reports are established in regulations and regulatory guides. In addition to the safety analysis reports, various supporting documents are submitted by the applicants to demonstrate the safety of the nuclear installation and the fulfilment of all the relevant legislative and regulatory requirements.

The review process performed by CNCAN is documented by one of the following means:

- evaluation reports;
- regulatory letters;
- inspection reports, containing findings and dispositions;
- written minutes as result of the licensing meetings (common meetings between CNCAN staff and the representatives of the license holder or applicant).

If the review concludes that all the requirements have been met by the applicant, a license is issued by CNCAN, for a specified period of time. All the limits and conditions derived for each specific case are clearly stated in the license, which includes sections devoted to quality management, emergency preparedness, radiation protection, reporting requirements, compliance with licensing basis documents, the hierarchy of documents of the licensee, etc.

For example, the content of a license for operation includes:
- facility and activities covered by the license;
- period of validity, provided that all conditions are met;
- general conditions specifying the documents on which the license is based;
- specific conditions on the facility organization and personnel;
- specific conditions for the operation (limits and conditions);
- specific conditions related to radiation protection of the personnel, public and environment;
- specific conditions regarding approvals for design changes and changes in the operating conditions;
- specific conditions for the management of records;
- specific conditions governing the procurement, possession, use, transfer, and storage of the nuclear fuel, of the nuclear and radiological materials, etc;
- specific conditions regarding safeguards;
- specific conditions regarding physical protection;
- specific conditions regarding quality management;
- reporting requirements (incident reporting, quarterly and annual reports);
- specific conditions regarding the periodic safety review;
- requirements on emergency preparedness arrangements.

The licensing process for siting, construction, commissioning and operation of a nuclear power plant is detailed under Articles 17 - 19.

For detailing the requirements in the Law with regard to the issuance of practice permits, the procedures and conditions for issuing a practice permit for the personnel involved in the operation and management of the nuclear installations are established in the Regulation on the licensing of operating personnel, management personnel and personnel in charge of specific training, applicable to nuclear power plants, research reactors and other nuclear installations (NSN-14 rev.1) and in the Regulation on the training, qualification and authorization of nuclear installations personnel with nuclear safety related jobs (NSN-23). More information on licensing of personnel with safety related duties is provided under Article 11 - Financial and Human Resources.

7.4 Regulatory Assessment, Inspection and Enforcement

In accordance with the provisions of the Law and of the regulations, CNCAN is empowered to request from the licensees, or from the applicants for a license, all the documentation needed for the regulatory decision making process on safety related matters. The documentation that needs to be submitted to CNCAN for review and approval is specified in the regulations and regulatory guides.

Additional support documentation is requested on a case by case basis and specified in regulatory letters, minutes of the meetings between CNCAN staff and licensee’s representatives, etc. According to the Law, the licensees and applicants have the obligation of facilitating CNCAN inspections and access to documentation and to provide all the information required by CNCAN.

The safety related documentation made available to CNCAN includes a large variety of documents, such as safety analysis reports, (quality) management manuals, different types of safety assessments and technical evaluations, information reports and procedures (reference documents, station instructions, operating procedures, work plans, etc.).

The responsibilities for the review and assessment of the technical documentation submitted by the licensees or applicants are assigned to the different technical units within the organizational structure of CNCAN.

The regulatory review activities are planned, performed and reported in accordance with internal procedures and instructions in order to assure the availability of internal resources and, as appropriate, external resources and to establish interfaces with the licensees. Each technical unit has specific attributions and develops assessment and inspection procedures and plans in the respective areas under their responsibility.

For major reviews, such as those performed by CNCAN prior to granting a license or an approval for a licensing milestone, interdisciplinary teams are established, which include experienced staff from all the technical units involved in the licensing of NPPs, with the necessary expertise for covering all the areas of review. Most of the experts responsible for the assessment of the safety related documentation participate also in the teams that perform the inspections. It should be noted that the assessments and inspections performed in the framework of the major reviews mentioned above are performed supplementary to the assessment and inspection activities deployed by each technical unit on a regular basis. The activities of the various technical units in the area of safety assessment and inspections for Cernavoda NPP are coordinated by the Director of the Nuclear Fuel Cycle Division (see the organizational chart of CNCAN, provided under Article 8 - Regulatory Body). The assessment and inspection criteria are specified in the regulatory guides and in the internal procedures of CNCAN.

The key objective of the CNCAN inspection program for Cernavoda NPP is to monitor compliance with the legal, regulatory and licensing requirements, and to take enforcement action in the event of non-compliance. The inspections for Cernavoda NPP are planned in a systematic manner, with the aim of ensuring a proactive identification of the deficiencies and deviations from good practices that could result in non-compliances.

The inspection planning for Cernavoda NPP is periodically reviewed and updated, taking into account new regulatory requirements, operating experience, plant modifications, organizational changes, information from regulatory oversight activities. The inspections are normally focused on those areas that would pose a significant risk, or for which a poor performance has been recorded. However, if an assessment finds good performance in an area, the results may be used to reduce the frequency and depth of the future inspections.

The inspections performed by CNCAN include:

- scheduled inspections, planned and performed either by each of the technical divisions, or jointly, with the occasion of the major licensing milestones;
- unscheduled and/or unannounced inspections, some of these being reactive inspections, in response to incidents;
- routines and daily observation activities performed by the resident inspectors.

Examples of regulatory oversight activities and tasks performed by CNCAN inspectors are given below:

- review of plant operation reports;

- review of progress on outstanding safety issues;
- review of the past safety performance of the plant;
- review of the status of committed safety improvements;
- management system audits;
- review of temporary and permanent modifications to ensure they are consistent with the licensing basis for the plant;
- system inspections;
- observation of operating practices and maintenance work;
- monitoring of the training program implementation;
- observation of emergency drills;
- monitoring of the radiological protection practices.

Resident inspectors in the NPP Surveillance Unit have an important role in the daily observation and assessment of the activities on site. The team of resident inspectors is responsible for producing the first draft of the annual inspection plan, which is then reviewed and supplemented by the staff in the CNCAN headquarters.

Examples of activities performed by the resident inspectors are given below:
- verification of the implementation of the dispositions and recommendations resulted from previous inspections;
- independent preliminary investigation of events significant for safety;
- inspections in the field, in the control rooms and in various areas of the nuclear installation, for observing and gathering information on the general progress of plant activities;
- detailed system inspections, for observing the performance of maintenance activities and the status of related documentation;
- daily verification of the various records and reports related to the operation of the plant;
- evaluation of the practices in different areas of activity to observe adherence to procedures, with focus on radiation protection aspects, preventive maintenance activities, testing of the special safety systems, personnel training, quality assurance;
- monitoring of the emergency preparedness arrangements;
- surveillance of the performance of activities during the planned outages with regard to configuration of the safety related systems, radiation protection of the personnel, work involving contractors, elaboration and review of the safety documentation (procedures, work plans, modification proposals, etc.);
- observing the performance of tests or other activities performed on safety related systems, usually according to an inspection plan that includes Witness Points (WP) and Hold Points (HP) (this approach is used mainly for monitoring the activities during planned outages).

A series of routine inspections is used by the NPP Surveillance Unit to monitor the physical state of the systems and the operating parameters, covering all safety relevant areas of the plant. The areas covered by the routine inspections are:

- Reactor Building;
- Service Building;
- Turbine Building;
- High Pressure Emergency Core Cooling Building;
- Emergency Water System Building;
- Secondary Control Area;
- Standby Diesel Generators Building;
- Spent Fuel Bay;

- Pump House;
- Chillers Building;
- Fire Response Command Area.

During planned outages, inspections are performed also in the areas not accessible during operation at power.

Besides the routines, the resident inspectors perform daily visits to the control room, for verifying the main operating parameters and the different aspects related to work planning and control of temporary modifications. The resident inspectors participate also as observers in the daily planning meetings of the plant management. Daily reports are elaborated by the NPP Surveillance Unit and forwarded to the CNCAN headquarters for information on the plant status and for ensuring awareness of any inspection findings.

The assessment and inspection activities performed by CNCAN staff are documented by one of the following means:
- assessment reports;
- inspection reports;
- written minutes of the meetings with licensee's representatives.

The inspection findings are categorized based on their importance to nuclear safety.

The documents resulting from the inspection activities are also distributed to the licensee, in addition to the regulatory letters that summarize the main regulatory requirements and dispositions based on findings arising from the review process.

In accordance with the provisions of the Law, CNCAN has in place a system to enforce compliance through graded measures. Therefore, the possible actions that CNCAN can take in the event of non-compliance are:
- dispositions for licensee action (these are stated in each inspection report);
- action notices/directives stated in regulatory letters;
- fines / monetary penalties;
- license amendments;
- restricted reactor operation;
- revocation or suspension of the license;
- prosecutions.

7.5 Use of IAEA Safety Standards

The IAEA Safety Standards have always been considered by CNCAN as a valuable source for the development of the regulatory framework. The main IAEA documents used for this purpose are the Safety Requirements and Safety Guides, but account is taken also of the Safety Reports, Safety Practice Documents and TECDOCs.

The regulatory activities in which CNCAN makes use of the IAEA Safety Standards can be summarized as follows:
- elaboration of regulations and regulatory guides;
- establishment of assessment and inspection procedures and criteria;
- development of the regulatory management system and elaboration of internal procedures.

In addition to using the IAEA Safety Standards for the development of regulations and guides, CNCAN uses these standards for developing its internal processes and procedures for review and assessment and for inspection of nuclear facilities and activities.

7.6 Significant regulatory developments after the Fukushima accident

Following the Fukushima Daiichi accident, CNCAN has focused initially on the technical reviews of the protection of the plant against extreme external events and of beyond design basis accident analysis, severe accident management and emergency response. After more information became available on the organizational factors that have contributed to the accident, CNCAN has used the lessons learned to improve the national regulatory framework, its practices for regulatory oversight of licensees' safety culture and its own safety culture. Several new regulations and regulatory guides have been issued in the period 2014 – 2016. These have been described in more detail in the 7th national report of Romania for the Convention on Nuclear Safety.

In July 2014, the National Strategy for Nuclear Safety and Security was officially approved by the Romanian Government and by the Supreme Council of National Defense, has been published and has come into force. The action plan issued for the implementation of the strategy has progressed well.

Acting upon the lessons learned from the Fukushima accident and from the safety reviews performed, CNCAN issued a regulation on the response to transients, accidents and emergency situations at nuclear power plants (NSN-07). The regulation was published in January 2014 and came into force in April 2014. A regulation - Nuclear safety requirements on the protection of nuclear installations against external events of natural origin – NSN-06 was published in January 2015. Regulatory reviews and inspections for verifying compliance with the new regulations have been performed in the period 2015 – 2017, resulting in dispositions that improved the procedures and processes for accident management and emergency response.

A new regulation on the operational limits and conditions (OLCs) for nuclear installations (NSN-05) has been issued in 2015. In September 2015, CNCAN issued the regulation NSN-20 - Requirements on the nuclear safety policy and on the independent nuclear safety oversight. The requirements on independent nuclear safety oversight have been established by CNCAN taking account of the international experience available in this area, including the information from various countries that have a long tradition in this practice, the conclusions in the Summary Report of the 6th Review Meeting of the Contracting Parties to the Convention on Nuclear Safety (paragraphs 21-22) and good practice guides used by the nuclear industry.

7.7 Significant regulatory developments for the last reporting period

In the last reporting period, CNCAN has issued several new regulations and regulatory guides, as well as revised/updated regulations, which consolidate the national regulatory framework for nuclear safety and ensure an improved basis for the regulatory oversight activities.

The relevant regulatory requirements and guidance documents issued in the last reporting period are presented as follows:

- NSN-16 - Nuclear safety requirements on surveillance, maintenance, testing and in-service inspections for nuclear installations (2018);
- NSN-17 - Nuclear safety requirements on ageing management for nuclear installations (2016);

- NSN-18 - Nuclear safety requirements on event reporting and analysis and on the use of operating experience feedback for nuclear installations (2017);
- NSN-21 - Fundamental nuclear safety requirements for nuclear installations (2017);
- NSN-22 - Regulation on the licensing of the nuclear installations (2019);
- NSN-23 - Regulation on the training, qualification and authorization of nuclear installations personnel with nuclear safety related jobs (2017);
- NSN-25 - Requirements on the decisional transparency in licensing process for nuclear facilities (2019);
- GSN-03 - Guide on fulfilling the overall nuclear safety objective set in the fundamental nuclear safety requirements for nuclear installations (2018);
- GSN-07 - Nuclear safety guide for the preparation of nuclear facilities refurbishment (2018);
- GSN-08 - Nuclear Safety Guide on restarting nuclear facilities after unplanned shutdowns (2019);
- GSN-09 – Guide on the development and assessment of nuclear safety culture (2019);
- Basic Requirements on Radiological Safety (BRRS, 2018);
- Regulation on the management of emergency situations specific to nuclear or radiological risk (2018);
- Regulation on the prevention, preparedness and response in case of emergency situations for the emergency preparedness categories I, II and III (2018);
- Regulation on the prevention, preparedness and response in case of emergency situations for the emergency preparedness categories IV and VI (2018).

New quantitative nuclear safety objectives have been established in the regulation NSN-21 and regulatory guide GSN-03. These have been presented in the Summary of this report, under the section dedicated to the Implementation of the principles of the Vienna Declaration on Nuclear Safety – Safety Goals.

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.

8.1 Description of the Attributions and Responsibilities of CNCAN

The general responsibilities and authority of CNCAN are stipulated in the Law, and are further detailed in the Regulation for Organization and Functioning of CNCAN, approved by Governmental Decision.

The mandate of CNCAN can be summarized as follows:

- CNCAN is the national authority competent in exercising regulation, licensing and control in the nuclear field, for all the activities and installations under the scope of the Law.
- CNCAN elaborates the strategy and the policies for regulation, licensing and control with regard to nuclear safety, radiological safety, non-proliferation of nuclear weapons, physical protection of nuclear installations and materials, transport of radioactive materials and safe management of radioactive waste and spent fuel, as part of the National Strategy for the development of the nuclear sector, approved by Governmental Decision.
- CNCAN is responsible to ensure, through the regulations issued and the dispositions arising from the licensing and control processes, that an adequate framework is in place for the deployment of activities under the scope of the Law.
- CNCAN is responsible for revising the regulations whenever necessary for the correlation with the international standards and ratified conventions in the nuclear field and for establishing the necessary regulatory measures for their application.

CNCAN has the following main responsibilities and authority:

- Initiates projects for normative acts in its areas of competence and issues regulations in the nuclear field, consulting as necessary the other authorities with attributions in this domain, according to the Law;
- Reviews and consents to all the normative acts with implications for the nuclear field, prior to their entering into force;
- Approves, in accordance with the law, the intervention plans for nuclear and radiological accident situations and participates in the intervention;
- Collaborates with the central authority for environmental protection and controls the implementation of the activities of the environmental radioactivity monitoring network;
- Requests to the competent authorities in the field of national security to perform the necessary checks for the persons with responsibilities in the field of nuclear activities, in compliance with the specific regulations;

- Initiates, with the consent of the Ministry of Foreign Affairs, activities for cooperation with IAEA and with other international organizations specialized in the nuclear field;
- Cooperates with similar institutions/authorities from other states;
- Controls the implementation of the provisions of international treaties and agreements in force, with regard to safeguards, physical protection, illicit trafficking, transport of nuclear and radioactive materials, radiation protection, quality assurance in the nuclear field, nuclear safety, safe management of spent fuel and radioactive waste, and the intervention in case of nuclear accident;
- Establishes and coordinates the national system for evidence and control of nuclear materials, the national system for evidence and control of radiation sources and of nuclear and radiological installations, and the national registry of radiation doses received by the occupationally exposed personnel;
- Cooperates with other authorities that have, according to the law, responsibilities with regard to the safe operation of nuclear and radiological installations, correlated with the requirements for the protection of the environment and the population;
- Ensures public information on matters that are under the competence of CNCAN;
- Organizes public debates on matters that are under the competence of CNCAN;
- Represents the national point of contact for nuclear safeguards, for the physical protection of nuclear and radiological materials and installations, for the prevention and combat of illicit trafficking of nuclear and radioactive materials, and for radiological emergencies;
- Orders the recovery of orphan sources and coordinates the recovery activities;
- Licenses the execution of nuclear constructions and exercises control over the quality of constructions for nuclear installations;
- Carries out any other duties stipulated by the Law, with regard to the regulation and control of nuclear activities;
- Transmits notifications and presents reports to the European Commission on the status of the implementation of the Council Directives;
- Approves the national strategies for the development of the nuclear sector and for the safe management of the spent nuclear fuel and of the radioactive waste;
- Organizes periodically, at least once every 10 years, self-assessments and international peer-reviews of its activities, as well as of the national regulatory framework.

8.2 Position of CNCAN in the Government Structure

CNCAN reports to the Prime Minister, through the Prime Minister’s Chancellery. CNCAN is completely separated and independent from all the organizations concerned with the promotion or utilization of nuclear energy. The responsibilities assigned to CNCAN by the Law are concerning solely the regulation, licensing and control of nuclear activities.

CNCAN exercises its functions independently from the ministries and other authorities of the central public administration, subordinated to the Government. The companies and organizations that operate or own the main nuclear and radiological installations are subordinated to the Ministry of Energy, to the Ministry of Economy or to the Ministry of National Education.

CNCAN is chaired by a President nominated by the Prime Minister. The position of the CNCAN President is assimilated to that of State Secretary. The President of CNCAN, with the advice of the General Secretariat of the Government, organizes the subsidiary structures of the divisions of CNCAN depending on actual needs and conditions of the activities of CNCAN. The organizational structure of CNCAN and the modifications thereof are approved by Governmental Decision.

8.3 CNCAN Organizational Structure and Human and Financial Resources

The current organizational structure of CNCAN is shown in Fig. 8.1.

As described under Article 7, CNCAN staff evaluate and process applications for CNCAN licenses; develop and prepare licensing recommendations; administer CNCAN policies and procedures; monitor, audit and inspect nuclear facilities and activities; draft and administer licenses; evaluate the qualifications and performance of licensees and their staff; prepare documents and reports; review reports and records; develop and enforce regulatory standards and requirements.

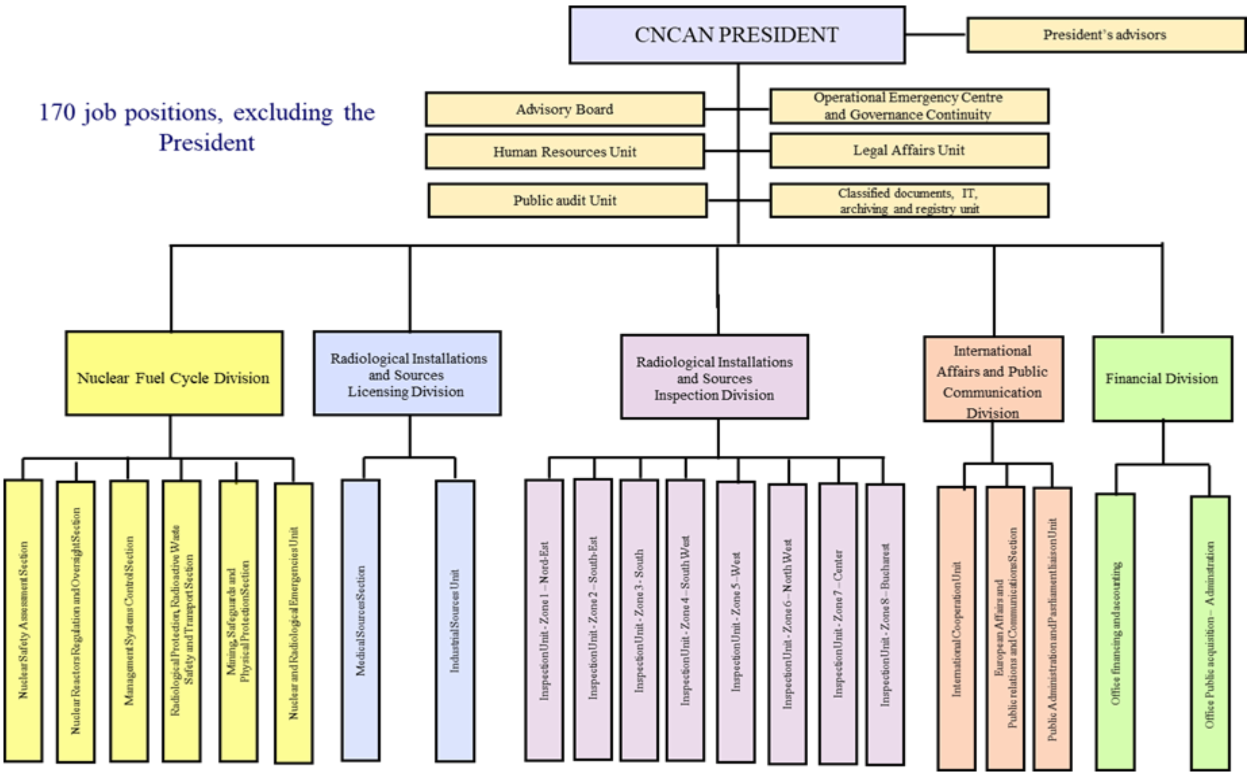


Fig. 8.1 CNCAN Organizational Structure

The division in charge of the regulation, licensing and control of nuclear installations, including Cernavoda NPP, is the Nuclear Fuel Cycle Division, composed of the following units:

- Nuclear Safety Assessment Section;
- Nuclear Reactors Regulation and Oversight Section, comprising of 2 units: Nuclear Regulations and Standards Unit and Cernavoda NPP Residents Inspectors Unit;
- Management Systems Control Section;
- Radiological Protection, Radioactive Waste Safety and Transport Section;
- Nuclear and Radiological Emergencies Section;
- Mining, Safeguards and Physical Protection Section.

There are currently 37 staff members working in the Nuclear Fuel Cycle Division of CNCAN, most of them being involved in regulatory activities related to Cernavoda NPP.

In specific cases, external consultants are also employed to assist CNCAN staff in review and assessment activities. In addition, CNCAN benefits from external expertise, when necessary, through IAEA technical co-operation projects and bilateral agreements with regulatory authorities from other countries.

As regards the financing, during the period 2004 - November 2009, CNCAN was collecting money for its budget from fees charged for performing inspection activities and technical assessments and for granting licenses, permits and authorizations and was self-financed. Starting with November 2009, all the money collected from taxes and tariffs for CNCAN activities have become revenue to the state budget and CNCAN is financed from the state budget through the General Secretariat of the Government (SGG). This has led to a reduction in the budget available to CNCAN in comparison to the period when self-financing was implemented.

The budget of CNCAN for the period 2012 – May 2019 is presented in Table 8.1.

Year	**CNCAN Budget (executed)** – RON (Romanian Currency)
2012:	11.992.000
2013:	9.516.000
2014:	10.830.000
2015:	9.228.000
2016:	8.552.000
2017:	8.534.000
2018:	10.988.000
2019:	10.992.000 (by 20th of May 2019) ~ 2.323.890 Euro

Table 8.1 – Execution of CNCAN budget for 2012 – May 2019

CNCAN has plans to increase the numbers of its technical staff in order to be able to improve the regulatory framework and processes, in line with the best international practices and has officially requested an increase in staffing numbers based on the current and foreseen workload.

In September 2018, the organizational structure of CNCAN has been modified to increase the number of staff. Several recruitment campaigns have been conducted and additional staff was hired. However, efforts are still ongoing to staff all the available positions with personnel having adequate educational background, experience and qualifications and to improve staff retention.

8.4 Management System

CNCAN has established and implemented a Management System in accordance with international standards and is currently revising it in order to implement the requirements in the IAEA GSR Part standard – Leadership and Management for Safety.

The Management Manual of CNCAN describes the policies with regard to the regulation, licensing and control activities, the strategic objectives and plans, the interfaces at national and international level, the responsibilities of the organizational units of CNCAN, the mechanisms for measuring, evaluating and improving the effectiveness and efficiency of the regulatory activities, etc. It also provides a set of general requirements applicable to the performance of activities within all organizational units and the specific requirements applicable to the assessment and inspection activities performed by the technical divisions.

The more detailed requirements and criteria are set in the procedures defining the various regulatory processes. In order to ensure the adequate implementation and improvement of the management system, the relevant procedures are sent for review and approval to all the divisions and departments. The Management Manual and all the internal procedures are available in electronic format on the local area network.

8.5 Cooperation with other national authorities

The licensing system is administered by CNCAN in cooperation with other governmental authorities (ministries and agencies) in such areas as environment, health, transport, industrial safety, security, etc. The issues raised by these authorities are taken into account before licenses are issued by CNCAN, providing that there is no conflict with the provisions of the Law and CNCAN regulations. All other licenses granted by other governmental authorities are prerequisites to the CNCAN licenses. An exception is the environmental authorization issued by the Ministry of Environment after the issuance of the operation license by CNCAN. The environmental agreement, issued by the same ministry is however a prerequisite to the siting license issued by CNCAN.

The Law gives a list of authorities having responsibilities in controlling various aspects related to nuclear activities. Although their responsibilities are established by the legislation in force, CNCAN has also signed formal Memoranda of Understanding with each of these organizations, for ensuring the prevention of potential gaps and overlaps in the implementation of their respective duties and responsibilities. The responsibilities of the other authorities empowered by the Law to control specific activities in the nuclear field have been described in detail in the previous reports and remain unchanged.

For ensuring transparency of its activities and decision making process, CNCAN routinely consults with and ensures information of all the organizations that have an interest in its regulatory activities, including licensees and other nuclear industry representatives, governmental, local and municipal authorities, departments and agencies as well as interest groups and individual members of the public.

8.6 International cooperation and exchange of information

In the area of international cooperation and exchange of information, CNCAN maintains relations with a number of nuclear regulatory authorities and organizations worldwide, through bilateral arrangements and commitments under international conventions in the nuclear field.

The international activities in which CNCAN is involved include the participation in the activities of WENRA and its technical working groups, the annual meetings of the Senior Regulators from countries that operate CANDU NPPs, the biannual meetings of the European High Level Group on Nuclear Safety and Waste Management (ENSREG) and its working groups, the contribution to the initiatives at European Union level and the participation in various IAEA activities, as well as the participation in the NEA/OECD committees and working groups.

In order to ensure the exchange of information relevant to nuclear safety, CNCAN has a number of bilateral agreements with regulatory bodies from other countries. In particular, CNCAN maintains frequent communications on regulatory matters with the Canadian Nuclear Safety Commission (CNSC) and US Nuclear Regulatory Commission (NRC).

Also, CNCAN has established agreements or arrangements with neighboring countries on notification and assistance in case of nuclear accidents.

With regard to technical assistance received from international organizations, CNCAN is a beneficiary of technical cooperation projects managed by the IAEA, at national and regional level. Through these projects, CNCAN receives expert missions and support in the organization of international and national seminars.

In 2013, CNCAN and the Norwegian Radiation Protection Authority (NRPA) have agreed to fund an IAEA Extra Budgetary Program (EBP) on safe nuclear energy in Romania. The “Regional Excellence Project on Regulatory Capacity Building in Nuclear and Radiological Safety, Emergency Preparedness and Response in Romania” started at the end of 2013 and was completed in 2017. The entire project was organized through an IAEA extra-budgetary program. The objective of the project was to enhance the capabilities of CNCAN in eight specific functional areas of work such as: safety analysis; integrated management systems and knowledge management; inspections; safety and security of transport and transit of radioactive and nuclear materials on the Romanian territory; emergency preparedness and response; ionizing radiation sources; radioactive waste, spent nuclear fuel management and decommissioning activities and safeguards activities. The project made a significant contribution to the improvement of CNCAN regulatory framework, processes and training of staff.

A new project, "Enhancement of Nuclear Safety and Security in Romania – Improvement of Disaster Resilience and Preparedness for Radiological and Nuclear Events" has started in 2019, as a continuation of the project implemented in 2013-2017. This project is being carried out in partnership with the Norwegian Radiation and Nuclear Safety Authority (DSA) and the International Atomic Energy Agency (IAEA), the national partners in Romania being CNCAN, as project promoter, together with the General Inspectorate of the Romanian Gendarmerie, the General Inspectorate of the Romanian Police, the General Inspectorate of the Romanian Border

Police, General Inspectorate for Emergency Situations and the Ministry of Internal Affairs (MAI). The implementation period of this project is 4 years and is funded through the Norwegian Financial Mechanism 2014-2021 - Home Affairs Program. The main objectives to be achieved in the project include alignment of the national framework and regulatory practices with the latest international standards and European Union legislation in the field of nuclear safety and protection against ionizing radiation; the implementation of recommendations from the international missions in Romania on nuclear safety, detection and response to events involving nuclear and radioactive materials not subject to regulatory control, cyber security for nuclear installations and training and intervention in case of emergency; implementation of several activities of the national action plan associated with the National Strategy for Nuclear Safety and Security; the implementation of the new responsibilities that CNCAN has in managing the nuclear emergency situations, as well as improving emergency preparedness and response by implementing lessons learned.

8.7 Training and qualification for the regulatory staff

CNCAN has a process to develop and maintain the necessary competence and skills of regulatory staff of the regulatory body, as an element of knowledge management. The required technical education, knowledge and experience, as well as the necessary skills and abilities are documented in the job descriptions for each job position with regulatory duties. To maintain an appropriate competence level, an annual plan for staff training is in place and each staff member has an individual training plan, elaborated by their respective line manager.

Training for CNCAN staff is provided either in-house or through technical cooperation programs with the IAEA and with other states and organizations. Members of the technical staff frequently attend training courses, workshops, technical meetings, expert meetings and conferences supported by the IAEA, that are relevant for their professional development in relation to their current and foreseen duties.

CNCAN also receives assistance through the International Regulatory Development Partnership (IRDP), sponsored by the US NRC. In the period 2014 – 2019, CNCAN staff received training through several activities organized in the framework of the IRDP. The training events completed in the last reporting period to support regulatory oversight activities for nuclear power reactors are presented as follows:

- Investigation and analysis of operational events at nuclear installations (2019);
- ASME O&M Code for Nuclear Power Plants Workshop (2018)
- Safety Analysis Report Review Training (2018)
- Computer Codes Used in the Regulatory Process Workshop (2017)
- Practical Basics Workshop for CNCAN (2017)
- Fundamentals of Reactor Safety and Regulations (2017)
- PRA and Fukushima Lessons Learned Workshop (2016).

Training received through the IAEA technical cooperation programs and through the US NRC IRDP program are particularly valuable in keeping CNCAN's technical staff up to date with the current international standards and good practices in nuclear safety and regulatory work, as well as with the relevant operating and regulatory experience.

8.8 Information to the public

The general Romanian legislation on public information and on transparency in the decision-making process of public authorities applies also to the regulatory activities of CNCAN. The main relevant laws are:

- Law 544/2001 on free access to public information;
- Law 52/2003 on decisional transparency in public administration.

In addition, the Law 86/2000 for ratification of the Convention on access to information, public participation in decision-making and to justice in environmental matters, done at Aarhus, on 25 June 1998 is also of relevance.

CNCAN responsibilities as established in the Law explicitly include:

- ensuring public information on matters that are under the competence of CNCAN;
- organizing public debates on matters that are under the competence of CNCAN.

For emergency situations, CNCAN has the responsibility to support the national authorities in providing the public with accurate, timely and comprehensive information regarding the emergency, through their representatives in the national committee for emergency situations.

The main means used by CNCAN for the current information of the public on regulatory activities and developments is the website (http://www.cncan.ro). Information available on the website includes:

- laws, governmental decisions and regulations applicable to the regulatory activities;
- laws and regulations in force, applicable to nuclear installations and activities, as well as draft regulations;
- annual reports on CNCAN's activity;
- reports submitted to international organizations;
- information about the history, organization and functioning of CNCAN;
- information on licensed installations and activities;
- press releases and information about conferences;
- forms for submitting requests for information.

Prior to the enactment of new or revised regulations, CNCAN posts the proposed drafts on its website and sends them for consultation to all interested organizations, for gathering information from the public, from licensees and applicants and from other interested parties.

Requests for information come mainly from non-governmental organizations and, to a lesser extent, from members of the public. CNCAN provides all the necessary data and clarifications, except for information that is classified due to security reasons.

The annual reports produced by CNCAN on its activities are published on its website and summary reports are published also in the Official Journal of Romania.

8.9 Significant developments for the last reporting period

In September 2018, the organizational structure of CNCAN has been modified to increase the number of staff. Several recruitment campaigns have been conducted and additional staff was hired. However, efforts are still ongoing to staff all the available positions with personnel having adequate educational background, experience and qualifications and to improve staff retention.

The “Regional Excellence Project on Regulatory Capacity Building in Nuclear and Radiological Safety, Emergency Preparedness and Response in Romania” funded by NRPA and CNCAN and managed through an IAEA EBP in the period 2013-2017 was successfully completed. The assistance received by CNCAN through this project contributed significantly to the improvement of the regulatory capabilities. In particular, in the framework of this project, CNCAN implemented a formal process for the training, qualification and certification of the inspectors for nuclear installations and issued several new or revised regulatory documents and procedures supporting the regulatory oversight of nuclear installations.

As mentioned in Section 8.6, a new project, "Enhancement of Nuclear Safety and Security in Romania – Improvement of Disaster Resilience and Preparedness for Radiological and Nuclear Events" has started in 2019 and is expected to further contribute to the strengthening of CNCAN’s regulatory framework and capabilities.

The assistance received by CNCAN through the International Regulatory Development Partnership sponsored by the US NRC, as mentioned in Section 8.7, also made a significant contribution to the development of CNCAN’s staff technical competence for regulatory oversight of nuclear installations.

As already mentioned in the Summary, in October 2017, CNCAN received a follow-up IRRS. The IRRS team found that Romania had systematically addressed the findings made by the previous mission, implementing most of its recommendations and addressing the lessons learned from the 2011 Fukushima Daiichi accident. The IRRS team noted that significant progress has been made in many areas. Specifically, 30 out of 34 recommendations and all 18 suggestions were closed. During the follow-up mission, the IRRS team developed 8 new recommendations and 4 new suggestions. The follow-up IRRS report has been made public on the IAEA website: https://www.iaea.org/sites/default/files/documents/review-missions/irrs_follow-up_mission_rep_romania_2017.pdf .

The developments of the regulatory framework have been presented in the chapter corresponding to Article 7.

ARTICLE 9 - RESPONSIBILITY OF THE LICENSE HOLDER

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

9.1 Definition of the legal responsibilities of the license holder

The Romanian Law on the Safe Deployment, Regulation, Licensing and Control of Nuclear Activities, further referred to as the Law, clearly stipulates that the prime responsibility for the safety of a nuclear power plant rests with the license holder.

As required by the Law, a license is needed for each of the stages of the life time of a nuclear installation. The general conditions that an applicant shall fulfil in order to obtain a license are presented in Annex 1, where the structure and content of the Law are described, and further detailed under Articles 17, 18 and 19. Compliance with the general licensing conditions, as well as with all the provisions of the Law that are directed to the licensee, with the provisions of the applicable specific regulations and with the conditions embedded in the license, is mandatory and enforceable.

The clear definition of legal obligations ensures that by no means the licensee's responsibility for safety could be diminished or shifted towards the regulatory authority. Compliance with the legislative and regulatory requirements does not relieve the licensee of its responsibility to ensure that safety is maintained and continuously improved.

The attributions and responsibilities of CNCAN are also stated in the Law, defining the role of the regulator in ascertaining that the licensees are taking all the necessary measures to ensure and maintain the safety of the nuclear installations. The regulatory system and processes for licensing, review, assessment, inspection and enforcement, as well as the responsibilities of CNCAN have been described under the Articles 7 and 8.

The main responsibilities of the license holder are stated in Chapter III of the Law and are further detailed in the specific regulations issued by CNCAN and in the conditions attached to each license. The articles 25 - 28 from the Law, relevant to license holders for activities directly related to nuclear power plants, are given below, for illustration.

Art. 25. - (1) The license holder has the obligation and the responsibility to take all necessary measures for:

a) ensuring and maintaining:

- *nuclear safety, protection against ionizing radiation, physical protection, on-site emergency preparedness and the quality assurance for the activities deployed and/or the associated radiation sources;*
- *a strict record of the nuclear and radioactive materials, as well as of all radiation sources used or produced in the activities under the license;*

b) complying with the technical limits and conditions stipulated in the license and for reporting any deviations, in accordance with the specific regulatory requirements;

c) deploying only activities covered by the license in force;

d) developing its own system of requirements, rules and instructions as to ensure that the licensed activities are carried out without posing an unacceptable risks of any kind.

e) ensuring and maintaining adequate human and financial resources for fulfilling its

obligations under the law.
(2) The liability for nuclear damage, caused during or as a result of an accident that could arise from the deployment of the licensed activities or of other activities resulting in the death, injury to the corporal integrity or health of a person, destruction, degradation, or temporary impossibility of using any goods, rests entirely with the license holder, under the terms established by law and by the international agreements to which Romania is a party.

Art. 26. - For the deployment of any nuclear activities generating or having generated radioactive waste, the license holder shall:
a) be responsible for the management of radioactive waste generated by the licensed activities;
b) bear the expenses related to the collection, handling, transport, treatment, conditioning and temporary or permanent storage of the waste;
c) pay the legal contribution to the Fund for the management and final disposition of the radioactive waste and spent fuel and for the decommissioning of the nuclear installations.

Art. 27. - The license holder shall:
a) develop and submit for approval to CNCAN a program for the preparation of the decommissioning;
b) produce the proof of having paid the legal contribution to the Fund for the management and final disposition of the radioactive waste and spent fuel and for the decommissioning of the nuclear installations.

Art. 28. - (1) The expiry, suspension or withdrawal of the license does not exonerate the license holder or the person having taken over the property title over the nuclear or radiological materials and installations covered by that license, from the obligations stipulated under Articles 25 - 27, nor from those deriving from the conditions stipulated in the license.
(2) Prior to the termination of the activities or decommissioning of nuclear or radiological installations, as well as prior to any transfer, partial or whole, of the nuclear or radiological installations and materials, the license holder shall apply and obtain, under the terms stipulated in the present Law, a license to own, preserve, decommission or transfer the respective installations and materials, as applicable.
(3) The license or practice permit issued on the grounds of the present Law does not exonerate the license or permit holder from observing the legislation in force.
(4) The termination of nuclear activities shall take place in compliance with the provisions of the specific regulations issued by CNCAN.
(5) CNCAN establishes the concrete modality of application of the present law whenever its provisions cannot be applied simultaneously with other legal provisions in force, with the consultation of the relevant public administration authorities, giving priority to the observance of the conditions for the safe deployment of the nuclear activities.

9.2 Mechanisms by which the licensees ensure and demonstrate the effective fulfilment of their prime responsibility for safety

In fulfilling its prime responsibility for safety, beyond simple compliance with the legislative and regulatory provisions in force, the licensee has developed and implemented its own system of requirements, rules, procedures and instructions, with the objective of ensuring that any risks associated with its activities remain acceptable and are minimised to the extent possible. This system is described in documents that form part of the licensing basis, for each stage of the lifetime of the nuclear installation, such as the Safety Analysis Reports and the Integrated Management Manual.

The safety related activities contracted to the external organizations are effectively controlled by the licensee, who acts as an intelligent customer and remains fully responsible for the implications of the work performed. The interfaces with the external organizations are described in the Integrated Management Manual and the license holder has in place a system for selecting contractors, training, monitoring and assessing their performance and maintaining effective communication with the aim of ensuring the consistent application of high standards of safety and quality.

The safety demonstration for licensing purposes has been addressed under Article 7 and is presented in detail under Article 14. Further information on the Integrated Management System of the licensee, including aspects related to the use of contractors, is provided under Article 13.

The license holder for Cernavoda NPP is the National Company Nuclearelectrica (SNN - Societatea Nationala Nuclearelectrica S.A.), which is the corporate organization having juridical personality. Although the authority for plant operation has been delegated to Cernavoda NPP Branch, the statutory responsibility for safety rests with the SNN.

In this respect, SNN is responsible to ensure that all the requirements deriving from the applicable legislation are fulfilled and to provide resources and support for the safe and reliable operation of Cernavoda NPP. The responsibilities discharged by SNN include the strategic planning and assignment of technical and financial resources necessary for the safe and reliable operation of the NPP, the fuel production and the research and development programs, the promotion of the safety and organizational culture, the provision of legal support, energy trading, project development, the administration of relations and interfaces with external organizations and regulatory authorities, and the information of the mass-media and the public.

Various mechanisms are in place to ensure awareness of safety issues at the corporate level and to inform and influence business decisions. Through the audits and independent assessments conducted by the Safety Department and the Quality Management Department, SNN ensures that the safety and quality policies are observed and applied to the expected standards and that the programs for the improvement of safety and quality are effectively implemented. The attributions and responsibilities of these organizational units are defined in specific procedures at corporate level. The corresponding activities and responsible units (e.g. independent assessment function, safety oversight, etc.) at the plant level are defined in the Integrated Management Manual of Cernavoda NPP and its specific plant procedures (these are further detailed under Article 13).

At plant level, safety is assessed quarterly by the Plant Safety Oversight Committee (PSOC). The role of this committee is to maintain awareness of the plant safety issues at the plant management team level, recommendations and expectations being provided to the managers, who subsequently inform the employees in their areas of activity. The strategy in place is to evaluate and review the plant safety performance, programs, actions and indicators. It initiates reviews and actions to improve and maintain high standards of safety and Safety Culture at the station. The Senior Superintendent of the Safety Department of SNN attends regularly these meetings and informs the SNN's CEO of the most important findings.

An agenda of a PSOC meeting usually includes the following items:

- Health Report for safety & safety related systems;
- Status of specific (individual) and generic safety related systems problems (specific and generic safety related and process equipment failures that have a potential negative impact on overall plant safety);

- The plant risk report for the previous quarter and the past 12 months, using the Risk Monitor for Equipment out of Service (EOOS tool);
- Verification of the internal and external operating experience, to identify the external initiating events that exceed the design basis or the operational levels, including the compensatory measures;
- Review of permanent design changes and temporary modifications status, including the global safety assessment of the implemented temporary modifications;
- Review of the status of the operating instructions for safety related systems and of the Abnormal Conditions with Compensatory Measures;
- Review of planned or implemented significant changes to any APOP (emergency operating procedures);
- Review of operational experience feedback and corrective actions - review of reportable events (since last meeting and trend report), trend of events reporting for different categories, significant external operating experience reported, status of root cause investigations;
- Review of regulatory actions resulting from the review, inspection and licensing processes, status of documents requiring regulatory approval;
- Progress status of the safety significant plant projects, such as Periodic Safety Review and Post-Fukushima Action Plan;
- The progress of open Technical Operability Evaluation/Operational Decision Making (TOE/ODM) actions and the actions closed in the last quarter;
- The progress of open actions resulted from Nuclear Safety Review Board (NSRB) report;
- Nuclear Safety Performance Indicators and Safety Culture;
- Status of the personnel authorization process;
- Any new items, as proposed in advance by PSOC members.

In addition, an Oversight Committee has been established at corporate level, which meets in quarterly meetings in order to analyze, validate and approve the reports submitted by the internal oversight team. After approval, the quarterly reports are presented, through the SNN Nuclear Safety Advisory Committee, to the Board of Directors for endorsement.

The means through which the licensee demonstrates its commitment to maintaining and continuously seeking the improvement of safety, include:

- initiating and establishing safety enhancement programs and ensuring the allocation of adequate resources;
- fostering the involvement of all plant personnel in the development of the management system;
- monitoring, reviewing and assessing the safety performance and taking timely actions to correct and prevent reoccurrence of any situations detrimental to safety;
- performing the systematic plant global safety evaluation through the Periodic Safety Review Program, and implementing the resulting action plan;
- the effective use of the operating experience feedback and of the results of the safety reviews and assessments in developing and maintaining up to date the safety related policies, programs, procedures and instructions, taking into account also the evolution of international standards and good practices;
- systematic implementation of the independent safety oversight process, to prove the fulfilment of the SNN safety policies;
- implementing the nuclear excellence model at Cernavoda NPP operating organization.

As a member of international nuclear operators' organizations, such as COG (CANDU Owners Group) and WANO (World Association of Nuclear Operators), the licensee has the opportunity to participate to the various programs and projects coordinated by these organizations, in order to enhance safety in plant operation through:

- sharing operating experience and best practices information between the members of the CANDU community, and also with the nuclear industry,
- attending Joint Projects on common nuclear issues,
- participating in Research and Development technical programs and projects, for safe future long-term operation,
- disclosing knowledge for leaders professional development towards leadership,
- receiving peer reviews and also participating as team members in the peer reviews for other NPPs.

In accordance with the reporting requirements imposed through regulatory documents and the licensing conditions, the reports submitted to CNCAN by the licensee for an operating nuclear installation include the following:

- Assessment Event Reports - to describe and assess the safety significance of some abnormal conditions that match specific criteria, related to public safety, environment protection, security or production;
- Quarterly Technical Reports (QTRs) - to present the overall technical performance and general information related to station operation for a period of three months; the fourth QTR of the year is issued as annual report. The QTRs provide information on the main aspects of Cernavoda NPP nuclear safety, dose statistics and radioactive effluents emissions, electrical energy production and outages, performance indicators, a review of process, safety and safety support systems including the design changes and mandatory tests performance, a review of the reactor performance, reportable events, procedural and organizational changes, nuclear fuel and heavy water management, the results of the radiation control and employee safety, radioactive waste management, a review of the emergency planning, a reactor core safety assessment. These reports include also information on the personnel training and authorization;
- Radiological Environmental Monitoring Reports - submitted periodically to present the results of the off-site radiological environmental monitoring program and any corresponding calculated doses;
- Periodic Inspection Program Reports - submitted within 90 days from the completion of any inspection carried out in accordance with the Periodic Inspection Program;
- Reliability Reports - submitted as a section of Quarterly Technical Reports, presenting, for each plant unit, the overall safety assessment, the risk report and the reliability performance of the containment system.
- Reports on the status of the training program for the licensed operations staff;
- Reports on the status of the Plant Systems Surveillance;
- Report on the status of the Systematic Assessment of Critical Spare Parts Program;
- Report on the status of the Preventive Maintenance Program;
- Report on the status of the Plant Life Management Program;
- Report on the status of the Safety Analysis Strategic Program;
- Report on the status of the Configuration Control Program;
- Report on the status of the In-service Inspection Program;
- Report on the status of the safeguards;
- Reports on the plant physical protection;
- Reports on the status of the actions resulted from the Periodic Safety Review;
- Reports on the status of the actions resulted from the post-Fukushima Stress Test;

- Updates of the Final Safety Analysis Report;
- Internal and external audit reports.

9.3 Interface between the license holder and CNCAN

The various interfaces needed to support the continuous communication between the licensee and the regulator are well established and described in specific procedures for all the safety related activities of the plant, which are subject to licensing, require approval from or notification to CNCAN, or that are under regulatory surveillance.

The regulatory activities related to Cernavoda NPP and the licensing process are coordinated by the Director of the Nuclear Fuel Cycle Division of CNCAN, which is responsible for integrating the activities of the various organizational units involved in safety review and assessment and in inspections and enforcement.

On the side of the license holder, the interface activities are formally managed by SNN CEO or by the Cernavoda NPP Director. The responsibility for maintaining the interface with CNCAN for the licensing activities has been delegated by the CEO of SNN to the Cernavoda NPP Director.

Cernavoda NPP, primarily through the Safety, Licensing & Performance Improvement Department, has a daily dialogue with the regulatory authority through the CNCAN site inspectors. Formal correspondence is exchanged as needed to clarify and resolve issues and to ensure that all requirements are met as required to obtain licenses, approvals and authorizations. In addition, CNCAN and Cernavoda NPP organize periodic working meetings, with agendas comprising of generic topics supplemented as necessary with specific items for discussion, to promote a free flow of information and to resolve small issues expeditiously.

In SNN Head Office the interface activities with CNCAN are coordinated and ensured by the Safety Department, and Quality Management Department. When necessary, the technical support is ensured by Cernavoda NPP specialists.

The main interface activities consist of:
- Licensing meetings;
- Regulatory inspections;
- Plant procedures and documents review and approval process;
- Investigations related to abnormal occurrences;
- Meetings for discussing draft regulations and guides;
- Development of Licensing Basis Documents and Licensing Program for future nuclear installations ;
- Regular information meetings for discussing the progress of various plant programs.

Maintaining a continuous communication with the license holder is of vital importance for CNCAN in discharging its statutory responsibilities.

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.

10.1 Safety Policy of Cernavoda NPP

In accordance with the Law, the licensee has the prime responsibility to ensure and maintain the safety of the nuclear installations. The regulations require the licensee to develop and implement policies that give safety the highest priority.

The general safety principles governing the activities related to the operation of Cernavoda NPP are stated in the following documents:

- the Nuclear Safety Policy, which is a document issued by the Plant Manager to be applied by the all personnel to all levels. The Nuclear Safety Policy, contains all the principles to be applied by the personnel to achieve the highest level of safety, and in
- Cernavoda NPP Integrated Management System Manual. The Manual is issued by the plant manager, and approved by the Regulatory body. The safety principles are taking over in all plant procedures, to be applied in all activities on site. The plant procedures contain clear responsibilities for the personnel at all levels, in order to protect the environment, personnel and equipment.

The principles stated in the Nuclear Safety Policy are reiterated and the specific means for their implementation are detailed in other station procedures (RD - reference documents, SI - station instructions, PSP – process specific procedures, etc.), defining the responsibilities of the station personnel. The implementation of these principles is also enforced by the provision of specific initial and refreshment training courses aimed at enhancing safety culture.

The major administrative control for the implementation of the Nuclear Safety Policy is the reference document entitled "Operating Policies and Principles" (OP&P). The OP&P is part of the licensing basis for the plant, and its initial issue, as well as modifications are subject to regulatory approval. This document describes how the utility operates, maintains and modifies the safety-related systems in order to maintain the nuclear safety margins. The OP&P contains the clear definition of the authorities and responsibilities of managers and operating staff. Also, it defines the specific operating limits for safety related systems, which must be maintained all the time to ensure that the plant always complies with its analyzed operating envelope.

In accordance with the conditions stated in the licenses for the units of Cernavoda NPP, compliance is mandatory with the provisions of the Nuclear Safety Policy, Operating Policies and Principles, the Integrated Management Manual, as well as with the provisions of any other procedure or document pertaining to the licensing basis.

As stipulated in the Nuclear Safety Policy, the governing principles in the OP&P shall not be intentionally violated under any circumstances. An overview of the principles stated in the Nuclear Safety Policy of the licensee, and of the means by which they are implemented, is given as follows.

a) *Nuclear Safety has the utmost priority, overriding if necessary the demands of production or project schedule. All decisions shall be made and reinforced consistent with this statement.*

This key principle of nuclear safety culture is governing the decision making processes and all the activities of Cernavoda NPP. The Nuclear Safety Policy document states the responsibilities for all employees (Station General Manager / Managers / Supervisors / Individual employees) and is communicated to all site personnel, including contractors, as part of their training.

The executives and senior managers evaluate the safety impacts and potential negative effects when making decisions related to major changes, including decisions concerning changes to organizational structure and functions, leadership, policies, programs, procedures, and resources.

The training syllabus includes specific requirements as to the know-how of the station objectives regarding nuclear safety, quality, personnel health and safety. The knowledge of these objectives and the associated requirements is annually refreshed for the personnel involved in the performance of safety related activities. The communication of the safety principles relevant for the performance of any task is also done as part of any pre-job briefing.

The mission, the vision and the objectives of the operating organization are communicated to all the personnel, published and clearly displayed throughout the site and on the utility intranet site that is available to all employees, as to ensure that all the individuals are conscious that through the correct and timely fulfilment of their assigned duties they contribute to the safe and reliable operation of the plant.

b) *To compensate for potential human or equipment failures, a defence in depth concept shall be implemented and maintained, applied at multiple levels of protection (prevention, surveillance, mitigation, accident management and emergency response), including successive barriers for the prevention of the release of radioactive materials into the environment.*

The plant design incorporates the various features of the defence in depth concept intended to provide adequate coverage for possible equipment failures. Station procedures are intended to maintain or enhance this through configuration control program, which provides the framework for the review and control all the proposed modifications, focusing on maintaining fission product barriers, defense-in-depth, and safety-related equipment. Human factors considerations are adequately taken into account in the design of the plant and in the development of procedures.

A comprehensive set of procedures covering all situations from normal operation to accident management is in place, structured, developed and maintained in accordance with the requirements of the management system and administrative controls are implemented, for adequate staffing, reviews and checks of activities prior to, during and after implementation, as appropriate. The work processes support nuclear safety and the maintenance of design margins by minimizing long-standing equipment issues, preventive maintenance deferrals, and maintenance and engineering backlogs.

A graded approach for the application of the management system requirements is implemented to ensure that the extent of approvals and reviews required is dependent upon the importance of the planned activity especially with regard to its impact on nuclear safety.

c) *Personnel engaged in safety related activities shall be trained and qualified to perform their duties. Taking into account the potential for human error, actions shall be established for facilitating correct decision-making by the operator and for limiting the possibility for wrong decisions, by providing the necessary means for detecting and correcting or compensating for errors.*

The overall training policies and the means for their implementation are defined in the reference documents “Station Training Process” and “Systematic Approach to Training”.

In accordance with the licensing conditions, the Nuclear Safety Policy and the provisions of the Integrated Management Manual, all managers and supervisors shall ensure that the staff is fully competent for their assigned duties. This includes training to ensure that individuals understand the safety significance of their duties.

Training of all new employees is provided according to the station instruction “Orientation training program for new employees”. The training program includes the provision of refresher courses to ensure that expertise is maintained at the required level. Each job position (or group of similar positions) has its own Job Related Training Requirements (JRTR) providing information about both the initial and continuing training needed for the specific job. JRTRs for each job position are reviewed by the line managers at least once per year based on the results of the staff performance evaluation.

The training received by contractors at the organization they belong to is verified as part of the evaluations / audits that the utility is regularly performing for all their suppliers of services, in order to ensure that they continue to maintain adequate standards of quality and safety and provide the expected level of performance. The license holder has also adequate arrangements to provide additional training for the contractors with regard to nuclear safety and safety culture aspects, plant specific features, etc.

More detailed information on the qualification and training of plant personnel is provided under Article 11.

d) *A strong organizational structure with well-defined responsibilities for nuclear safety at all levels shall be established and maintained.*

The Station Organizational Chart and associated Job Descriptions document the general areas of responsibility. The responsibilities and lines of authority are clearly defined in the Integrated Management Manual and also included and detailed, as appropriate, in the Reference Documents and Station Instructions, including those activities, checks, reviews and approvals needed to ensure that safety is properly taken into account in all activities.

The operating license includes specific conditions on the plant organizational structure and staffing, requiring that these shall be in accordance with the provisions of the approved Integrated Management Manual and that the modifications to the organizational structure and staffing levels shall be adequately justified and documented and shall be reported in writing to CNCAN within 30 working days prior to their implementation, for regulatory review and approval. Further information on the management of organizational change is provided under Article 13.

e) *Operation of the plant shall be conducted by authorised personnel following administrative* *controls and adhering to approved procedures.*

Training and qualification programs have been in place to ensure that staff can be authorised for their assigned duties. All formal authorizations for personnel required to be licensed by CNCAN for station operation have been received.

The station system of documents providing administrative instructions and operating procedures includes the Integrated Management Manual, Reference Documents, Station Instructions, Operating Manuals, Maintenance Procedures, etc. These documents are issued and kept updated to ensure an adequate procedural framework for the conduct of plant activities in a safe manner.

The duty Shift Supervisor has the overall responsibility and authority for the safe operation of the unit and the safety of all persons on site both during normal operation and in abnormal situations. The Shift Supervisor shall act in accordance with the requirements of the Operating License and Operating Policies and Principles and must adhere to these requirements at all times. On-shift licensed operators have the authority and responsibility to place the plant in a safe condition when faced with unexpected or uncertain conditions.

All managers, senior superintendents and superintendents are responsible to ensure that the staff is fully competent for their duties, that tasks are carried out as defined in procedures and that procedures are complete, clear and unambiguous. This includes training, observation and coaching to ensure that individuals understand the safety significance of their duties.

f) *The safety review of procedures, analyses and design changes shall be completed before the effective commencement of the work.*

This requirement is generally included as a responsibility of those who prepare and those who verify any safety related documents and is specifically addressed and detailed by the various station procedures. In particular, the Safety and Compliance Department is given a special responsibility to review station documents, such as Operating Manuals, Operating Instructions and Design Manuals, to ensure that all the safety requirements are met.

The different stages of review and testing of modifications provide reassurance that the safety is not adversely affected. Further information on the safety categorization and the assessment of modifications is provided under Article 14.

By maintaining an effective communication with the plant vendor and other utilities operating and providing support for the operation of CANDU NPPs worldwide and participating in the research and development projects within the CANDU Owners Group (COG), the utility ensures that the current state of the art for safety is also taken into account when planning and designing any important plant modifications.

g) *Procedures will be followed and, when unexpected situations arise, appropriate expert assistance shall be obtained before proceeding. In such cases, the safety intent of the procedures shall be maintained.*

For cases in which situations may occur which had not been previously analyzed and for which no adequately clear and detailed procedures had been prepared, conservative decisions are required to ensure that no activities are initiated which could have a negative impact on safety.

Asking for guidance from more experienced or qualified persons when facing an unfamiliar task or situation is required at all staff levels. The importance of asking for guidance from the immediate supervisor when unsure what to do is emphasized during staff training.

Any activity that would imply a deviation, even temporary, from a procedure or work plan has to be assessed from the point of view of its impact on safety, justified and planned in detail, and the approvals needed for its performance need to be obtained from the same level of authority as for the procedure or work plan that would have been normally followed. The elaboration, verification and approval of any special procedures which would be needed for the performance of such activities would follow the normal process in accordance with the provisions of the Integrated Management Manual.

Specific procedures such as "Abnormal Condition Reporting" (ACR), “Technical Operability Evaluation (TOE)” and “Operational Decision Making” (ODM), together with their supporting documents define actions to be taken in cases where unexpected situations arise while the unit is in normal operation, including power manoeuvres, maintenance, testing, refuelling, or for cases not fully covered by procedures, which could be regarded as deficiencies in plant documentation. The occurrence of initiating events or accident situations is covered by using the emergency operating procedures. More information on operating procedures is provided under Article 19.

h) *A set of operational limits and conditions shall be defined to identify safe boundaries for plant operation.*

The boundaries for safe operation, based on the safety analyses for the plant, are included in the appendixes of the OP&P. The technical basis for the operating limits and conditions in the OP&P are provided in Chapter 16 of the FSAR.

OP&P documents the safe envelope within which the plant is to be operated, setting the limits and conditions for normal operation and the actions to be taken by the operating staff in the event of deviations from the OLCs (Operating Limits and Conditions).

Operating Policies and Principles (OP&P) covers all operational states and temporary situations arising due to maintenance & testing, containing administrative controls, the limiting safety system settings and the limiting conditions for operation and stipulating the minimum amount of operable equipment.

Actions to be taken in case of deviations from the OLCs and the time allowed to complete these actions are provided in the “Impairment Manual”. References to this document are made in OP&P and the Impairments Manual is available in the control room.

Detailed surveillance requirements, design specific features and specific administrative controls are provided in the system Operating Manuals (OMs), Operating Manual Tests (OMT) and Standard Operating Sequences (SOS).

i) *Events significant for safety shall be detected and shall be subject to in-depth evaluation, and measures shall be implemented promptly to correct the root causes, to disseminate the lessons learned and to monitor the effective implementation of the corrective actions. Plant management shall have access to safety relevant operational experience from other nuclear power plants around the world.*

The Reference Document "Operating Experience Program" contains the Plant policies for Operating Experience. Specific guidance is given in other supporting documents, such as Station Instructions (SI), Process Specific Procedures (PSP) and Internal Department Procedures (IDP), which include provisions for the reporting, analysis of events (including low level events) and the determination and tracking of corrective measures required.

The procedure “Abnormal Condition Reporting” describes the process of identification, evaluation and analysis of the Abnormal Conditions occurred at Cernavoda NPP or at other nuclear power plants worldwide, in order to determine adequate corrective actions to preclude occurrence of major events or their recurrence in case that they already have occurred.

The plant personnel is responsible for:
- Identifying and reporting the abnormal conditions occurred at the plant;
- Maintaining a focus on lessons learned from in-house and industry experience and actively promoting the use of operating experience in current activities;
- Implementing the corrective actions resulted from operating experience process;
- Reporting of the actions implemented to the next level of management.

The abnormal conditions discovered in the plant which can or could have effect on nuclear safety, personnel safety, radiological protection, environment or production are recorded, screened based on their impact and systematically analyzed. Specific root cause analysis methodologies are applied for those events exceeding a certain threshold, and the analysis is performed in multi-disciplinary teams addressing the equipment, human performance and organizational aspects.

Actions resulting from the analysis of the plant events are concurred by management and have assigned responsibilities and target dates for completion. The corrective actions address causes and contributors, and they might be corrective, preventive or for improvement.

Specific activities are formalised within departments/sections, through which information and lessons from internal and external operating experience are systematically searched and used within current activities (jobs evaluation and planning, pre-job briefing, modification processing, training, industrial safety, etc).

The reports for events meeting the criteria in the procedure “Reportable Events to CNCAN” are issued to the Regulatory Body in a written format, in accordance with the provisions of this procedure.

Further information regarding the investigation of abnormal events and the dissemination of lessons learned is provided under Article 19.

j) *A questioning attitude when dealing with safety issues is expected from every employee and shall be encouraged. Recognition of, and admitting to mistakes shall also be encouraged. When sanctions are necessary, these shall not be applied in such a way as to encourage the concealment of errors.*

Management does not use direct sanctions against individuals as a result of incidents or errors. Any repetition of problems or individual patterns of poor performance are dealt with collectively, through interviews and performance appraisals with the objective of determining the cause and helping the individual to make corrections. Any punitive measures taken are not connected to specific incidents. As a result, an open environment has been created for reporting problems and errors by various levels of staff.

When the employees engaged in activities affecting safety related functions or structures, systems and components believe that a deficiency in nuclear safety exists, they are responsible for notifying their Supervisor, the Safety & Licensing Manager and/or the Station Manager. If in the employee's opinion the notification does not receive appropriate attention, the employee has the right and obligation to contact successively higher levels of management (an escalation process has been implemented) Also, a procedure for reporting employees' concerns is implemented.

k) *Cernavoda Operating Policies and Principles (OP&P) shall not be knowingly violated. If conditions are found to exist which conflict with the OP&P, the affected system(s) shall promptly be placed in the normal configuration or in other known safe state or the reactor shall be promptly placed in a safe shutdown state.*

Where deviations from the Operating Policies and Principles are needed, justification is properly documented and CNCAN approval is obtained prior to the event. Unplanned violations of the limits are promptly dealt with using Operating Manuals and Impairment Manual guidelines for ensuring the correct course of actions and meeting the appropriate time limits. Such violations are reported to the regulatory authority in accordance with the reporting requirements.

l) *A set of nuclear safety standards shall be established against which the safety performance of Cernavoda NPP shall be assessed. Where these standards are not met, corrective action shall be implemented.*

The policy statements of the operating organization with regard to health and safety, quality and environmental protection are given in the Integrated Management Manual of Cernavoda NPP. The authorities and responsibilities of the management at all levels are also defined, with the senior management being responsible for the development and the implementation of the Integrated Management System for Cernavoda NPP, aligned with the requirements of the Quality Management System of SNN and in compliance with all the regulatory provisions and the applicable standards. The connection between the safety of the plant and its reliable operation is recognised and reflected in the policies of the operating organization.

Cernavoda NPP has established and implemented a self-assessment process for continuously evaluating the performance of the systems and processes of the plant. The criteria used in evaluating the performance have been established for each area of activity, based on WANO and OSART guides and standards, as well as on the internal procedures of the station. Focused self-assessments are periodically conducted to evaluate the activities and processes and identify the potential for improvements and optimization. The actions resulted from these evaluations are included for tracking in the Action Tracking Database as Improvement Actions.

Specific objectives and performance criteria are established for each area of activity within the management system for Cernavoda NPP. For each process, appropriate performance indicators are established, which are periodically reviewed (monthly, quarterly, biannually or annually) and their results and trends are reported to the management level. A color code is associated with each performance indicator so that a qualitative interpretation of the performance can easily be made. For indicators which have negative trends indicated by associated yellow or red color, assessments are performed to identify the causes and corrective actions are established aimed at improving the performance of the addressed activity and implicitly the associated indicators.

The performance indicators data is reported monthly in a graphical format to indicate trends, allow comparisons of actual versus expected results. Whenever targets are not met or adverse trends are observed, actions are initiated for determining the reasons and for implementing corrective actions. The performance indicators are also included in the quarterly reports submitted to the regulatory body CNCAN.

m) *The station shall comply with all regulatory nuclear safety requirements. The station shall resolve with the regulatory authority any requirements or interpretations of these that would not appear to be beneficial to the health and safety of the public or the workers.*

The license holder retains the primary responsibility for the safety of the plant when implementing any changes to processes or systems that may affect safety. The changes resulting from regulatory review and inspection activities follow the normal plant processes for the initiation, assessment and implementation of modifications.

The various regulatory requirements that are integrated in the framework of the management system are carefully reviewed to ensure that their intent is fully understood and that there are no conflicting requirements. Clarification is sought from CNCAN and the other regulatory authorities, as the case may be, for any requirement the interpretation of which needs further detailing.

(n) *Managers at the most senior level shall demonstrate their commitment to nuclear safety by giving continuous attention to the processes that have a bearing on safety and by taking immediate interest in the significant safety issues when these occur.*

The primary responsibility for nuclear safety at Cernavoda NPP resides with the senior management, who initiates regular reviews of the safety performance of the organization and of the practices contributing to nuclear safety with the objective of achieving and maintaining an effective safety culture and a high level of operational safety. Adequate arrangements are in place to ensure that safety significant issues are timely brought to the attention of the senior management. Specific processes, such as “The safety assessment by management (Plant Safety Oversight Committee - PSOC)”, “Operational Decision Making” and “Technical Operability Evaluation” are established and implemented to ensure that due priority is given to any safety significant issues.

The management team of the plant meets daily to focus on the safety and production issues and the Site Manager provides context and direction to the team. Information on the regular reviews of the management system is provided under Article 13.

(o) *Managers shall ensure that the staff respond to and benefit from established practices (culture) and by their attitude and example shall ensure that their staff is continuously motivated towards high levels of performance in discharging their duties.*

Management oversight and feedback is provided daily in a field observation program. All management levels act as role models with regard to the implementation of the safety policy of the plant. The Manager's field assessment program requires the managers to inspect the plant areas according to a specific monthly program. After finishing the assessment, the manager has to discuss issues with the participants of the evaluation and also reinforce the management expectations such as work quality, safety, conservative decision-making, reactor safety and public safety, depending on the involvement of the workers. Information on the observation and coaching by managers is provided under Article 12.

10.2 Overview of the regulatory activities for the evaluation of the safety management of the plant

CNCAN staff routinely audits the license holder's compliance with the OP&P and the Nuclear Safety Policy and perform regulatory inspections to ensure adherence to station procedures. In order to evaluate the safety management at the plant, CNCAN checks the compliance with the regulatory requirements following the regulatory procedures established for assessment and inspection, as described under Article 7. CNCAN verifies that the licensee has accomplished its responsibility, to ensure the continuous availability of safety-related fundamental resources, including adequate management, operation and support personnel, and the various physical plant resources needed for the safe design, testing, operation, and maintenance of the plant. The results of CNCAN assessment and inspections are incorporated into the licensee's overall plant management and corrective action programs. The issues and findings are viewed in terms of trends as well as their apparent risk.

The results of plant continuous monitoring and periodic safety assessment by the licensee are available to the regulator by means of Shift Supervisors Log, Quarterly Technical Reports, Surveillance Programs, results of Probabilistic Safety Assessments and Deterministic Nuclear Safety Analyses and also by communication with CNCAN site-dedicated inspectors, on daily basis. In monitoring the licensee's arrangements for managing safety, CNCAN reviews the use of indicators throughout a licensee's organization to improve safety and the measures taken to prevent adverse trends in any of the safety related indicators.

The following are just a few examples of generic data sources used by CNCAN for regulatory assessment of safety culture:

- policy documents emphasising priority to safety;
- procedures that describe safety-related processes and activities;
- self-assessment guidelines;
- self-assessment reports and safety performance indicators for various processes (e.g. training, maintenance, etc.);
- results of (quality) management system audits and reviews, reports from the independent nuclear safety oversight group, reports from external reviews;
- previous inspection reports;
- records of past events and corrective actions implemented;
- interviews with licensee's staff at various levels (managers, supervisors, workers) during the inspections; observations during common meetings;
- observation of activities in the field (e.g. corrective maintenance work, preventive maintenance work, chemistry activities - sampling/analyses; surveillance/testing; nuclear plant operator rounds; new fuel receipt and inspection; shift turnover; control room and simulator evolutions; system/component clearance activities; hold point activities; training – initial / refreshment; maintenance planning meetings; outage planning meetings, etc.).

Evaluation of safety management and safety culture is an integral part of all regulatory activities for Cernavoda NPP. All the routine regulatory reviews and inspections reveal aspects that are of certain relevance to safety culture. Interactions with plant staff during the various inspection activities and meetings, as well as the daily observation by the resident inspectors, provide all the necessary elements for having an overall picture of the safety culture of the licensee.

The main regulations supporting CNCAN’s assessment of licensee’s safety culture are:
- NSN-20 - Regulation on the nuclear safety policy and independent nuclear safety oversight for nuclear installations (2015).
- NSN-21 - Fundamental nuclear safety requirements for nuclear installations (2017).
- NSN-23 - Regulation on the training, qualification and authorization of nuclear installations personnel with nuclear safety related jobs (2017).

Details on these regulations have been provided in the chapter corresponding to Article 7.

10.3 Significant developments for the last reporting period

Regulatory developments

In the last reporting period, CNCAN issued specific regulatory requirements on the development and assessment of nuclear safety culture, on management systems supporting safety culture and on the inclusion of safety culture and leadership aspects in the training of all personnel, including management. These requirements have been included in the regulations NSN-21 and NSN-23, mentioned above.

In addition, in 2019, CNCAN has issued a regulatory guide on the development and assessment of nuclear safety culture, to facilitate the implementation of the regulatory requirements in NSN-20, NSN-21 and NSN-23, as well as to support the regulatory oversight activities of CNCAN in this area. The regulatory guide is based on the document INPO 12–012, Traits of a Healthy Nuclear Safety Culture, Revision 1, Institute of Nuclear Power Operations, 2013 and on the 37 attributes promoted in the IAEA safety guides on management systems for nuclear installations GS-G-3.1 and GS-G-3.5. The regulatory guide recommends that the licensee performs a self-assessment to determine its own model of organizational culture and identifies the elements that support nuclear safety in the categories of artefacts, espoused values and basic assumptions, building on the model of organizational culture developed by Edgar Schein. The guide recommends that the traits of a healthy nuclear safety culture, outlined in the INPO document mentioned above, as well as the nuclear safety culture attributes promoted by the IAEA, are adopted by the licensee’s organization and are used for the development of safety culture, as well as for self-assessment.

Developments on the licensee's side

The Cernavoda NPP Safety Culture Framework was developed in 2006 starting from the 3-layers organizational culture model (Edgar Schein, 1992) and a set of observable characteristics which include shared beliefs and assumptions, principles which guide decisions and actions, management systems and controls, patterns of behaviour of leaders and employees and the physical state of the working conditions and equipment. The framework was constructed based on international guidance of IAEA, INPO and WANO in this area, so the observable characteristics are in accordance with those described in the reference documents issued by these organizations.

The framework was constructed based on international guidance of IAEA, INPO and WANO in this area, so the observable characteristics are in accordance with those described in the reference documents issued by these organizations.

The framework consists of the following characteristics of the safety culture:
- Objectives and results indicate a strong regard for safety;
- Equipment is in good condition, core reactivity is managed and physical working conditions are safe ;
- Management systems are effective;
- Leadership behaviours show the regard for safety;
- Individual behaviours show the regard for safety;
- Organizational learning is embraced.

A cross-reference analysis between the Safety Culture Framework characteristics and INPO/WANO Traits of a Healthy Nuclear Safety Culture and attributes was performed, showing that Cernavoda Safety Culture Framework covers all aspects included in the WANO document “Traits of a Healthy Nuclear Safety Culture” and it is a consistent working model for safety culture.

Based on the safety culture framework, safety culture surveys were developed, using web-based questionnaires that allow for anonymous data collection. Data collection and interpretation of the results has been performed by plant specialists, with consideration toward the workforce’s norms, behaviours and perceptions.

The last safety culture survey performed in 2017 showed a high regard of personnel for safety, including respect for the regulators, and priority given to safety in all activities. Workers confirm a careful cautious approach with a willingness to stop work when something unexpected is encountered. Operators have comfort with shutting down the reactor if an uncertain situation occurs.

Leaders frequently reinforce nuclear safety through daily messaging, and trust is high between the workers and leaders. Observations of meetings, work activities, and decision-making confirmed that nuclear safety overrides other priorities. Robust risk management processes are well-used. Operating experience and benchmarking are highly valued and used to improve station processes, procedures, equipment and training programs. Station, corporate, and independent monitoring of nuclear safety is frequent and critical.

The results of all activities performed for the assessment and monitoring of safety culture are provided to management review during periodic meetings. The safety culture survey results are complemented with other methods document reviews, observations, interviews or focus groups, analysis of events from the point of view of safety culture characteristics, etc. Improvement actions were taken as a result of the surveys.

In 2018 a self-assessment was performed of the attributes for efficient leadership / coordination teams within Cernavoda NPP, the training approaches and the mechanism for their assessment, in line with the latest standards applicable in the nuclear industry. The strong points were related to high alignment of leadership team, defining a superior attitude related to the mission and common vision, roles and responsibilities within the team, decision-making and team engagement. Valuable training and information materials on leadership and teamwork topics have been developed, which will help strengthen leadership and team performance.

The station has implemented a detailed plan for conveying the nuclear safety culture message and developing the behaviours of a learning organization. Methods used vary for different groups of personnel and include Safety Culture Training. All new employees receive initial safety culture training, which is one full day course on nuclear safety culture principles. Contractor personnel are fully integrated into staff nuclear safety culture training. An annual computer-based refresher training regarding healthy safety culture traits is requested for all personnel. Also training was provided for all station personnel on the attributes of a “no-blame” culture to encourage the reporting of issues.
The persons who enter in the licensing program for operators take a two-day, advanced level course on safety culture comprising ten case studies. All personnel complete an annual requalification on safety culture training that includes recent operating experience.

Case studies for “engaged thinking organizations” were developed and discussed with the personnel. These case studies emphasize that leaders and supervisors maintain their oversight roles; behaviours and performance of all personnel are maintained at the highest level; risk is recognized, understood and managed and workers understand and anticipate the effects of their actions. The use of relevant operating experience and recognition and challenge of consequences of repetitive or long-standing issues are also highlighted by these case studies.

These training activities consolidate the characteristic of a “learning organization” and sustain the emphasis placed on safety in every activity at Cernavoda NPP.

Posters which enforce healthy safety culture behaviours at managers’, supervisors’ and workers’ levels are available within the working spaces, and other visual materials highlighting the safe working practices, prevent event tools and use of operating experience are posted in the plant.

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.

11.1 Legal Provisions Stating the Obligation of the Licensee for Ensuring the Availability of Adequate Financial and Human Resources

As required by the Law, the licensee is responsible for ensuring both adequate financial and human resources to support the safety of the Cernavoda NPP throughout its lifetime.

The relevant paragraphs of the articles 18 and 25 of the Law are quoted below:
Art.18. "A license for deployment of activities involving nuclear installations (as specified in the art. 8 of the Law) shall be granted only if the applicant fulfils the following conditions:
a) is capable of demonstrating the professional qualification, for all job positions, of its own personnel, the personnel's knowledge of the nuclear safety and radioprotection regulatory requirements, the probity of the personnel that have authority for decision making in managing the work deployed during construction and operation of the nuclear installation or in managing other activities in the nuclear field (of which mentioned at art. 8 of the Law);
b) is responsible to ensure that the personnel, permanently or temporarily employed, which deploys professional activities in vital points of the nuclear installation or has access to classified documentation, is reliable and licensed by the competent authorities in this regard;
c) is capable of demonstrating that has all the human and financial resources, the technical resources, technologies and material means necessary for the safe deployment of its activities.
[…]
e) is responsible that the personnel assuring the operation of the nuclear installation have the necessary knowledge, as appropriate for the position assigned, with regard to the safe operation of the installation, the risks associated, and the applicable nuclear safety measures.
f) takes all the necessary measures, at the level of the current technological and scientific standards, to prevent the occurrence of any damage that may result due to the construction and operation of the nuclear installation;
[…]
j) has adequate and sufficient material and financial arrangements for the collection, transport, treatment, conditioning and storage of radioactive waste generated from the licensed activities, as well as for the decommissioning of the nuclear installation upon termination of operations, and has paid the contribution for the establishment of the fund for the management of radioactive waste and decommissioning
Art. 25. - (1) The license holder has the obligation and the responsibility to take all necessary measures for:
[…] e) ensuring and maintaining adequate human and financial resources for fulfilling its obligations under the law.

These obligations are also stated and further detailed in the nuclear safety regulations and in the conditions of the licenses granted by CNCAN. The status of the financial and human resources is periodically reported to CNCAN through the Quarterly Technical Reports (QTRs).

11.2 Availability of resources to support the safety of Cernavoda NPP throughout its lifetime

The license holder for Cernavoda NPP is SNN (National Company Nuclearelectrica), a company listed at the stock market, with the Romanian government owning the majority of the shares. It has the authority to raise revenue through the sale of electricity in order to ensure that adequate financial resources are available to support the operation and the safety of Cernavoda NPP throughout its lifetime.

Based on actual rate changes and the predictions for the future, detailed analyses have shown that sale of energy on the market will ensure in Romania enough financial resources to operate the plant and support improvement programs as necessary.

Cernavoda NPP maintains one budget structured as Operation and Maintenance and Capital Improvement respectively. The plant budget is based on the budgets prepared by each plant division, which include salaries, training, investments, consumables and services. The Site Manager, the Administration Board and the Ministry of Economy and Finances, approve the plant budget, based on the capacity of energy production of the plant and in an amount that guarantees the safe operation of the plant, including the necessary investments to maintain and improve the plant performance.

The budget for Operation and Maintenance usually covers most of the safety improvements to the plant. However, if the need arises for improvements at a larger scale, as for example as an outcome of the Periodic Safety Review, it is expected that these will be covered by the Capital Improvement section of the budget. Such situations are factored in for establishing the future electricity rate to be charged to the customers.

The expenditures of SNN are dictated by the company's financial position, current and planned performance, service obligations (load forecast), and financial and business strategies. These inputs are used to develop a set of affordability envelopes, one for ongoing operating expenditures, and one for capital investments.

11.3 Financing of Safety Improvements

As a rule, ongoing safety-related programs are financed from the operations and maintenance envelope, and large scale improvement projects, including safety related projects, are financed from the capital envelope. In either case, the costs of safety improvement programs / projects would become part of the base rate and recovered through rates charged to customers.

Within each envelope, programs/projects are ranked in accordance with prioritization criteria that reflect the corporation's operating, business and financial objectives. The license holder assigns a high priority to safety-related programs and projects and ensures that adequate financial resources will be provided to support the safety improvements throughout the life of the nuclear power plant.

Starting with 2006, by signing an agreement to join the R&D Program within the COG, SNN became a participant member, obtaining access to the results of the research performed after the date of the agreement coming into force. Starting with 2007, SNN acquired the voting right and participates actively in the COG R&D Program.

In order to make more effective use of the research results, as well as for promoting work in areas of special interest for Cernavoda NPP, the licensee has established the procedural framework for developing the related projects and has nominated a project responsible in his own organization, as well as in the structure of the COG. The specialists from the Romanian research institutes are also involved in the activities of evaluation and assessment of the results made available through the COG R&D Program.

11.4 Financial Provisions for Decommissioning and Radioactive Waste Management

Up to present, the licensees, including Cernavoda NPP, had to pay an annual contribution for supporting the activity of the Nuclear Agency and for Radioactive Waste (AN&DR, which is the competent authority for the coordination, at national level, of the safe management of spent nuclear fuel and of radioactive waste, including disposal) and for deployment of activities mentioned in the annual plan for waste management and decommissioning.

At Cernavoda NPP, the costs of the current activities for the management of spent fuel and radioactive waste, including the costs associated with the Intermediate Spent Fuel Dry Storage Facility, are included in the operational costs.

For the costs associated with the long term management, such as disposal of spent fuel and radioactive waste management, including decommissioning costs, SNN pays the financial contributions to the Fund for Radioactive Waste Management and Decommissioning.

The annual contributions of the licensees to the fund have been set by the Governmental Decision regarding the establishment and the administration of the financial resources necessary for the safe management of the radioactive waste and for the decommissioning of nuclear and radiological installations.

11.5 The Rules, Regulations and Resource Arrangements Concerning Qualification, Training and Retraining

Romanian regulations related to Training, Qualification and Retraining for operating personnel for research reactors and nuclear power plants have been in place since 1975, well before starting the construction of Cernavoda NPP. When Romania bought the CANDU technology, the training issue had been considered since the early phase of the contract negotiations. The initial training for management, operation, technical and maintenance key personnel was provided in Canada. More than 100 persons were trained in an operational Canadian nuclear power plant prior to be assigned to any commissioning / operation activities, in order to allow them to fulfil their position responsibilities safely, effectively and efficiently.

Together with the technical design, Romania bought the training concept and training programs for operation, fuel handling, maintenance, and radiation protection staff. The adopted programs have been continuously adapted and improved based on IAEA Guides related to NPP Personnel Training & Qualification, and INPO / WANO recommendations related to Training System Development. In this way, a Systematic Approach to Training (SAT) has been implemented in Cernavoda NPP training activities.

Reference Documents (RD), Station Instructions (SI), and Process Specific Procedures (PSP), have been put in place to establish a structural Training Process for NPP Personnel.

11.5.1 Training Organization and Facilities

The complexity of the facilities and equipment of a nuclear power plant requires high quality manpower and its preservation in time. Therefore, the license holder considers the work performed in the human resources field as a priority and particular attention is paid to the strategy related to personnel recruitment and personnel loyalty / jobs stability, as well as to the sustained improvement of training quality.

The plant organizational structure includes a Human Resources Training and Development Department, headed by a Senior Superintendent who reports directly to the Site Manager. The Site Manager has the overall responsibility for the qualification of plant personnel and supports the Human Resources Training and Development Department with the necessary resources including staffing and facilities.

The Human Resources Training and Development Department provides support for plant departments to achieve the station goal of having competent and qualified staff capable of ensuring the safe and reliable operation of the Cernavoda NPP and is in charge of coordinating all the training activities at the plant through the departmental Training Coordinators.

The structure of the training organization, the accountability, functional responsibilities, level of authority and lines of communication facilitate the accomplishment of established training goals and objectives.

The responsibility of identification and ensuring the relevant training to a particular position rests with the direct supervisor of that position. This responsibility is extended for any job change that arises in his/her department. The Human Resources Training and Development Senior Superintendent helps supervisors to identify future needs for training and development by monitoring personnel performance, training and work activities, plant and external operating experience.

The managers and supervisors are responsible to ensure that production requirements do not interfere with the need for personnel to be trained. In order to allow the entire personnel to fulfil their position responsibilities safely, effectively and efficiently, all staff is provided with appropriate opportunities to take the relevant training, before they are assigned to carry out tasks that require the corresponding knowledge or skills.

The Training Centre has 24 classrooms that are well equipped with white boards, smart boards, flipcharts, video projectors and computer systems. Some of them have equipment, spare parts, and mock-ups that represent plant components or are equipped with computers for Computer Based Training. Also, some of the classrooms are used as study rooms and are equipped with current reference documents, procedures, and training manuals.

Maintenance training facilities were built for mechanical, electrical, C&I, general services activities. A series of mock-ups were built-up (steam generators, fuel channels, etc.) which have increased opportunities for equipment familiarization and practice prior to important or infrequent jobs.

A Full-Scope Simulator is mainly used for the initial and continuing training of licensed personnel, Shift Supervisors and Control Room Operators, in order to provide them with the necessary knowledge and skills to conduct plant operation from the control room in a safe, reliable, and professional manner, both in normal and abnormal conditions. Taking into account that the Full-Scope Simulator has operating characteristics similar to those of the Unit 1, in order to be used for Unit 2 operators' training, the differences between Unit 1 and Unit 2 were analyzed and documented. Subsequently, during the training development phase, the different tasks were identified and suitable training methods were built into the program. Also, the simulator is used for the regulatory examinations of the personnel applying for the practice permits issued by CNCAN.

Before the implementation of any modification at the plant, all the necessary safety assessments and evaluations are made and if the modification influences the simulator proper actions are established. Physical fidelity of the simulator is maintained by analysis of the changes made to the plant Main Control Room (MCR) and providing appropriate modifications.

The simulator facility is equipped with video cameras that provide the possibility to record all the training activities made during each session. It is also possible to record all the major parameters during the training session and to keep the data for debriefing purposes.

11.5.2 Training Programs for Cernavoda NPP personnel

According to Cernavoda NPP training policy, the plant staff shall be qualified to perform their duties in a safe and reliable manner.

Training programs are based on Systematic Approach to Training (SAT) principles and address the essential capabilities and qualifications to support plant operations.

The application of SAT principles involves the following stages:

- Analysis of training needs
- Design of training programs
- Development of training programs
- Training implementation
- Training evaluation.

Each department of Cernavoda NPP performed a job analysis to identify initial and continuing training requirements for effective job performance, and then documented training requirements by preparing a generic Job Related Training Requirements (JRTR) or Qualification Guide for each position, or group of similar positions. Particularly, for some positions, the training requirements were identified based on reviewing task analyses of similar job positions performed by nuclear industry.

Having the training requirements for each position, the training objectives have been established and the training materials developed. Based on this, it was possible to design and implement training programs for all plant personnel. In addition to the knowledge and skills required to ensure and maintain the technical competence, the training requirements related to development of managerial and supervisory skills are also included in JRTRs or Qualification Guides.

In order to ensure that all plant personnel have sufficient understanding of the plant and its safety features, the Initial Training Program for plant personnel consists of two main parts:

- General training program;
- Specific training program.

The general training program is provided to all employees in order to familiarise them with the plant, its physical layout, its basic operation, the station organization and the basic administrative procedures which govern its day to day operation. In addition, the program provides an introduction to industrial safety, nuclear safety, the quality assurance program, the requirements for radiation protection and actions in the event of an emergency situation on site.

The specific training program is based on job specific courses and activities in order to provide the knowledge and skills, as well as familiarization with the reference documents, station instructions and work procedures, for a particular job. Science fundamentals and nuclear technologies, plant systems training and on-the-job training are the main parts of the specific training program.

After completion of the training, written and, as necessary, practical tests are provided to ensure mastering of the acquired knowledge by the trainees and their ability to perform work safely. In addition, an evaluation of the trainees' performance at the work place is made by their supervisors to assess and correct the knowledge assimilated and skills achieved.

Continuing training programs were defined and implemented in order to maintain and improve employee's job performance and to develop their position-specific knowledge and skills. Continuing training programs cover re-qualification for any qualifications that have a specified lifetime, refresher training to maintain and improve skills, lessons learned from industry operating experience, update training derived from plant systems/equipment modifications and procedure changes, performance improvement training to correct performance problems or identified weaknesses in knowledge and skills related to their duties.
Continuing Training Plans covering a five-year period were developed for each job family, ensuring the implementation of the Continuing Training Curriculum established by the Curriculum Review Committees.

11.5.3 Overview of the Training Programs for the major categories of Cernavoda NPP personnel

Control Room Operators and Shift Supervisors

The scope of the programs and the content of the specific training courses are based on the Job and Task Analysis completed for the respective job positions.

In order to be selected in the training program for initial authorization the candidate for the Control Room Operator (CRO) position must meet a number of requirements such as:

- Medical and psychological exams passed successfully.
- Successfully passed a defined number of courses and be already internally authorized in radiation protection, field operations in all areas of the plant, electrical authorization, Control Room Assistant position, Work Control Area position.
- Successfully performed all the Advanced System Field Check-outs.
- Successfully completed the Core Generals Training Program (Science Fundamentals and Nuclear Technologies training courses that have been deemed as essential knowledge requirements for Control Room Operators).

The Initial Licensing Training Program for CRO is 24 months long and consists of:

- Systems specific training – advanced system training, control programs training, Romanian laws, Operating Polices and Principles, Abnormal situations and transient response. The duration of this training is 12 months. At the end of this training, the candidate has to pass a written and oral exam administered by the national regulatory body - CNCAN.
- Simulator training on operator response to normal operation and to major transients and abnormal operating procedures. The duration of this training is 6 months. At the end of this training, the candidate has to pass a simulator-based test administered by CNCAN.
- Co-piloting – practical training related to Main Control Room panel configuration, systems test and operation under direct supervision of an authorized person. The duration of this training is 6 months.

For the Shift Supervisor (SS) position, the Initial Licensing Training Program prerequisite is a valid license as a Control Room Operator for at least two years. The duration of Initial Licensing Training Program for Shift Supervisor is 9 months. Also, the candidate for the Shift Supervisor position has to pass written, oral and simulator exams administered by CNCAN.

In order to retain a current authorization, Cernavoda NPP licensed personnel (CRO and SS) has to attend a continuing training program (refresher courses - at least 4 weeks per year, emergency training courses, qualifications - radiation protection, electrical, Secondary Control Area, etc.)

Re-authorization of the Control Room Operator and Shift Supervisor is required at every 5 years. The candidate has to pass the re-authorization examinations conducted by CNCAN.

Field Operators

The training topics for the field operators training and qualification program are established based on the training objectives coming from the results of job analyses and from performance evaluations. The training programs and related materials are developed by the Human Resources Training and Development Department and validated by the Operations Department. Along with the courses provided by the Human Resources Training and Development Department, skills checks are conducted in the field by an OJT (on-the-job training) instructor. At the end of every training session, the operators are evaluated by written tests (following classroom training), or by field and practical evaluation (following the on-the-job training).

The training and qualification program for plant operators allows for streaming of operators into separate qualification (duty) areas of plant operation, such as Balance of Plant, Common Support Systems etc.

Continuing training program for field operators covers re-qualifications, refresher training, lessons learned from industry operating experience, update training derived from plant systems/equipment modifications and procedure changes, performance improvement training to correct performance problems or identified weaknesses in knowledge and skills related to their duties.

Maintenance Personnel

The Training and Qualification Programs for maintenance personnel were developed based on training requirements resulted from Table Top Analysis and contain the classroom training (orientation, science fundamentals, equipment and nuclear technology, plant systems), organised and delivered by the Human Resources Training and Development Department instructors, and skills training, organised and delivered by the Maintenance Department as On-the-Job Training.

All the maintenance staff is monitored by management and supervisors to ensure their qualifications are adequate for the assigned duties.

The continuing training included classroom training and practical training provided at the mock-ups or plant equipment in the workshops to maintain necessary skills and qualifications.

Technical Support Personnel

The Training and Qualification Program for the Technical Engineers follows the philosophy of Duty Area training and qualifications set out in INPO ACAD 98-004 - Guidelines for Training and Qualification of Engineering Personnel.

Orientation and general technical training (science fundamentals, nuclear technologies, basic systems etc.) are delivered by the Human Resources Training and Development Department. Duty Area Mentoring training is done via the Technical Departments.

Duty areas have been defined for System Engineers, Design Engineers and Component Engineers. Within each duty area, a set of tasks has been established. Skills and abilities have been identified for each task and the supporting courseware to provide the underlying knowledge and skills has been specified in Qualification Guides. A formal evaluation covering tasks in a duty area is required before the engineer is qualified to work in that specific area.

Instructors

Training Instructors, both full-time and part-time, must be technically competent in the training elements they teach or evaluate. Instructors' tasks and activities are analyzed to identify the knowledge and skills needed to perform their instructional responsibilities.

An initial training program is designed to ensure that instructors possess the technical competence and instructional skills necessary to conduct high quality training, including training in SAT principles, adult training theory, and training methodologies and media, and are evaluated at least annually on their training delivery performance. Continuing training programs are aimed at maintaining and improving the instructional and technical skills following initial instructor qualification. Considering simulator training of the licensed operators as a very important part of their development and for maintaining ability to fulfil the responsibilities dictated by their position, the Simulator Instructor positions are staffed with experienced operators, who are currently or have been previously authorized as Control Room Operators. Also, they are authorized by CNCAN.

Part-time instructors from plant departments are involved in OJT and some specific training courses (radiation protection, management system, emergency response etc.). All of them are experienced people that have completed the instructors' qualification program.

Periodically, the Human Resources Training and Development Senior Superintendent and the training supervisors monitor and evaluate instructors' performance to ensure that training staff possess and maintain the technical knowledge appropriate for their positions and the instructional capabilities appropriate for their training functions. Feedback forms from observations and self-assessments are also used to check the quality of the training provided.

Management Personnel

Cernavoda NPP management staff has an essential role in setting the standards and expectations for all personnel in all aspects of organization's activities. In addition, it is essential that management staff themselves visibly meet these standards and help their staff to understand why these standards are appropriate. Also, Cernavoda NPP managers have a major influence on organizational culture. They are expected to maintain high levels of nuclear safety and at the same time to be more efficient in reducing the cost of production. Such circumstances underline the need to give managers of all levels the necessary training to succeed in such a demanding environment.

Based on the necessary competencies, roles and responsibilities required for the management staff, a Development and Training Program is established and implemented.

The content of the management staff development program was established in order to allow for individualised development and also to support the identification of the specific individual manager's needs.

The focus of the training is on management and leadership courses in order to achieve, maintain and improve the managerial and supervisory abilities and leadership skills. The courses are developed and delivered in relation with two management categories: supervisory and senior management and their respective roles, responsibilities and competencies.

The content of the training has two major components: Initial and Continuing training. Initial training includes internal courses delivered by Cernavoda NPP instructors, plant Subject Matter Experts (SMEs) or by external experts and external courses provided, on or off site, through international organizations (COG, WANO, INPO, IAEA etc.).

Continuing training is designed to assist the management staff to maintain and improve their job performance and to develop their position-specific knowledge and skills.

A leadership training program was also developed and implemented at worker level to improve personal effectiveness.

Contractors

All contractor personnel should be trained and qualified to perform their specific task for which they are contracted. Training and qualification of contractors to perform their specialised tasks are typically provided by their parent company. Cernavoda NPP, with the involvement of the department responsible for the contractors' work, has the obligation of evaluating the formal training and qualification of the contractor personnel, in order to verify and guarantee their competence.

A training program is also provided for contractor personnel before they are allowed to work on site, which includes basic knowledge of plant layout, the basics of plant operation, station organization and administrative procedures governing its day-to-day operation. In addition, the program provides an introduction to conventional and nuclear safety, safety culture, the relevant requirements of the plant's management system, the requirements for radiation protection, and action in the event of an emergency situation on site. Additional training is also provided for some of the contractors, as necessary, on selected parts of the position-specific initial training.

Continuing training program for contractor personnel includes lessons learned from industry operating experience, applicable equipment modifications or procedural changes related to their work, radiation protection re-qualification, as well as additional training on selected subjects of the initial specific training.

Personnel with emergency response functions

For plant management, technical and operating staff with emergency response functions, the training program includes basic topics related to: typical scenarios for nuclear accidents and potential threats / consequences, differences between Design Basis Accidents, Limited Core Damage Accidents and Severe Core Damage Accidents, decision making criteria in the early phase of an accident, the use of the Severe Accident Management Guides etc.

Radiation protection training

According to the provisions of the Law, any licensee has to use, in its activities, only personnel possessing a practice permit, valid for these activities. This practice permit is issued, after an evaluation and an examination, by CNCAN or by the licensee, according to specific regulations which establish the requirements on qualification, examination and the practice permits issuing procedures, for the professionally exposed workers, radiological protection officers and qualified experts in radiological protection.

Furthermore, according to the provisions of the Basic Standards on Radiological Safety, the licensee must ensure the information of the professionally exposed personnel with regard to the radiological risk on their health due to the activities performed, the general procedures and the necessary measures on radiation protection, as well as the importance of observing the technical, medical and administrative measures. Also, the licensee has to ensure the adequate training of the professionally exposed personnel, in the field of radiological safety and the refreshment of the training, every 5 years, with 2 practical evaluations in this period, through a training system recognized by CNCAN.

Thus, Cernavoda NPP has in place a training program on radiation protection, for all the personnel working on site, not only its own employees, but also external workers. Since 2007, following a CNCAN audit, Cernavoda NPP was designated as accredited body for the certification of the training of personnel in the field of radiation protection at Cernavoda NPP.

11.5.4 Review and Update of the Training Programs

The training programs are periodically evaluated and revised to maintain and improve personnel training. The evaluation of training performance is provided by managers, supervisors, and the Human Resources Training and Development Department, according to the plant procedure "Training Evaluation Process".

The evaluation of the training programs effectiveness is based on:

- feedback from management and supervisors observation of the training activities;
- feedback from trainees;
- feedback from evaluation of classroom instructors or on-the-job instructors;
- feedback from post-training evaluation;
- feedback from self-assessment of training activities;
- analysis of training indicators.

The Human Resources Training and Development Senior Superintendent, line managers and supervisors periodically observe training activities (classroom, simulator, on-the-job training etc.). Personnel performance is observed periodically, as part of Human Performance Program, to verify that training and qualification programs are producing competent workers. Feedback from participants and their supervisors on training content and how well the training program prepared the personnel to perform their jobs is used to revise and improve the training program. Analysis of results of post-training evaluations and observations of the employees' performance at the work place help to determine potential training improvements. The areas for improvement identified are analyzed in the Training Committees. Any changes in plant procedures, processes and systems/equipment modifications are analyzed to identify any impact on training programs, materials and settings and to initiate and implement the necessary corrective or improvement actions.

11.5.5 Training through external organizations

This category includes training courses in cooperation with external organizations (IAEA, WANO, INPO, COG, EPRI, manufacturers, equipment suppliers etc.) and development activities (fellowships, workshops etc.) organised or sponsored by above-mentioned organizations.

Also, Cernavoda NPP has a good cooperation with Romanian specialised organizations which provide training for plant personnel in the areas of technical and skills training to meet the national legal requirements related to qualification and authorization of plant staff.

Training provided by external organizations is well controlled according to the plant procedure "Training through outside organizations". Feedback forms filled out by trainees are analyzed to make a decision about future needs.

11.6 Regulatory activities for assessing training effectiveness

Specific requirements in the area of training are provided in the following regulations:

- Regulation on granting practice permits to operating, management and specific training personnel of Nuclear Power Plants, Research Reactors and other Nuclear Installations (NSN-14 rev.1),
- the General Requirements for Quality Management Systems Applied to the Construction, Operation and Decommissioning of Nuclear Installations (NMC-02),
- Regulation on the training, qualification and authorization of nuclear installations personnel with nuclear safety related jobs (NSN-23),
- Basic Requirements on Radiological Safety and
- Regulations on issuing Working Permits for nuclear activities and designation of Qualified Radiological Protection Experts.

The Regulation on granting practice permits to operating, management and specific training personnel of Nuclear Power Plants, Research Reactors and other Nuclear Installations (NSN-14 rev.1) defines the conditions that the applicants shall fulfil in order to obtain a practice permit from CNCAN and contains also detailed requirements on the training programs for the categories of licensed personnel, with special focus on the control room operators.

The categories of licensed personnel for NPPs, as stated in the above-mentioned regulation, together with the corresponding job positions for Cernavoda NPP, are listed as follows:

a) The Nuclear Power Plant Personnel for operating activities in the Main Control Room - Control Room Operators and Shift Supervisors.

b) The Nuclear Power Plant Personnel for Management activities:
1. Site Manager;
2. Station Manager;
3. Production Manager;
4. Technical Manager;
5. Health Physics Senior Superintendent;
6. Operation Senior Superintendent;
7. Human Resources Training and Development Senior Superintendent;
8. Management System Superintendent;
9. Safety and Compliance Senior Superintendent;
10. Maintenance Senior Superintendent;
11. Physical Protection Superintendent.

c) The trainers/ instructors involved in the specific training activities for operators.

The regulation establishes:

- The qualification requirements for the operating personnel, starting from the commissioning phase of the nuclear installation up to complete removal of the nuclear fuel from the core, the management personnel and the specific training trainers/instructors;
- The steps of the licensing process for each category;
- The methodology of granting the practice permits for the above mentioned personnel and covers:
    - Objectives of candidate’s assessments;
    - Content and phases of evaluation;
    - Methodology of examinations by CNCAN;
    - Criteria and performance indicators.

CNCAN examinations are performed in accordance with the provisions of the regulation and the internal procedures which are part of the Quality Management System of CNCAN and the directives issued by the CNCAN senior management with regard to the nomination of the members of the examination board and the rules for conducting the examination.

The general subjects/topics for the examination of Operating Personnel (CRO & SS) are chosen to be relevant for the knowledge of nuclear installation safety systems, operating limits and conditions, capabilities to operate under normal conditions, abnormal conditions or emergency conditions, team working skills, communication and coordination skills. The examinations consist of written and oral tests and practical examination at the Full Scope Simulator (static and dynamic tests). An independent evaluation of the co-piloting training in the NPP Control Room is also done by CNCAN.

Regarding the examination of the instructors, the technical knowledge, skills, attitudes and instructional capabilities in their assigned areas of responsibility (classroom, simulator etc.) are evaluated.

The examination objectives in the evaluation of management personnel are chosen to reflect the performance associated with the job at all three levels: organizational, as part of a process, and at individual level. The content of the examination is established to give an overview of the candidate's knowledge, skills, attitudes and capabilities in specific areas of responsibility.

The examination consists of an interview covering different aspects related to the organizational structure, management system processes, responsibilities and levels of authority, human performance issues, safety culture, work planning, coaching, and observation of their subordinates.

The practice permits granted by CNCAN following the satisfactory performance of the candidates in all the subjects/tests of the examination, are valid for a definite period of time, provided that the licensed person has continuity in the same activity and a good performance on the respective job.

The training programs for the licensed personnel are submitted to CNCAN for review and approval. The implementation of the training programs for all personnel with duties important to safety and the observance of the station training policy are also extensively reviewed and assessed by CNCAN through periodic audits.

11.7 Significant developments for the last reporting period

11.7.1 Significant developments of the licensee's training process and facilities

Since 2016, progresses have been made in improving the training programs for Cernavoda NPP personnel in order to achieve a high level of performance in training and qualification of plant staff with duties important for the safe and reliable plant operation.

Some actions have been implemented to increase the efficiency of the training process. Thus, the training committees (CRC and TPRC) have been reorganized and optimized, measures have been implemented to reduce both the number of training documents approved by senior management and their approval time, opportunities have been identified for efficient use of training database etc. Training procedures have been reorganized and revised to detail the specific activities and align them with the latest international standards, as well as to include the necessary measures to de-bureaucratization of the training process.

The evaluation of training programs health was improved according with the nuclear industry best practices and the performance indicators were revised. Shortfalls in training programs' effectiveness are evaluated and presented to plant management in TOC (Training Oversight Committee) meetings together with the corrective actions taken to ensure training improves performance.

The full-scope simulator fidelity has been improved by replacing the DCC-X emulator with the emulator of both the DCC-X and DCC-Y process computers. Also, the implementation of some project modifications contributed to the improvement of simulator fidelity:

- replacing the operator desk in FSS MCR,

- replacing the main generator excitation model with a new simulated GE EX 2100e excitation system with an emulated HMI;
- installing automatically switch of Low Pressure ECC
- replacing F&P regulators with Yokogawa controllers.

11.7.2 Significant regulatory developments

In 2017, CNCAN issued a new regulation, NSN-23 – Nuclear safety requirements on the training, qualification and authorization of personnel of organizations operating nuclear installations. This new regulation supplements the NSN-14 rev.1 regulation mentioned above and includes requirements on the application of the systematic approach to training for all personnel, as well as specific requirements for the selection, training, qualification and authorization of managers, including examination and licensing by the regulatory authority, for all the job positions important to nuclear safety (as identified by the licensee), from general director / CEO down to chief engineer/department manager level.

NSN-23 requires that the specific programs for personnel with management, coordination and supervisory functions ensure the systematic development of management and leadership competences. In addition to the licensing of management personnel by CNCAN, the new regulation also addresses the members of the management board, who have to be interviewed by CNCAN, which can issue an opinion or recommendation based on the results of the interview.

The new regulation NSN-23 also includes an annex with objectives for the examination of managers by CNCAN and an annex with examples of questions for testing managers' knowledge. The same annexes apply also to the regulatory interviews of members of the board.

The examination objectives and examples of questions are structured into 4 categories (similar to the IAEA 4-quadrant model for regulatory competences):

1) knowledge of the applicable nuclear legislation (6 objectives, 8 examples of questions);
2) technical knowledge (10 objectives, 30 examples of questions);
3) knowledge of the management system and of the processes of the nuclear organization (10 objectives, 48 examples of questions);
4) knowledge, skills and attitudes supporting a healthy nuclear safety culture (12 objectives, 51 examples of questions).

Many of the examples of questions in quadrant 4 are aimed at testing internalization of the attributes in INPO 12-012, Traits of a Healthy Nuclear Safety Culture, Revision 1, Institute of Nuclear Power Operations, 2013.

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.

12.1 Managerial and Organizational Issues

The importance of the human performance in ensuring the safe operation of a nuclear power plant is recognised by both the license holder and CNCAN. While the importance of human factors for the design is considered as vital, the focus has been lately shifting towards the human performance issues associated with the construction, the commissioning and the operation stages.

Efforts are made to continuously enhance human performance, by means of:
- developing and improving the mechanisms by which the human errors can be detected, analyzed and corrected;
- developing and enhancing the training programs to effectively incorporate the operating experience feedback;
- develop and enhance means to correctly evaluate human performance.

The organizational and managerial philosophy adopted at Cernavoda NPP takes into account the capabilities and limitations of human performance and the responsibilities for ensuring and improving the quality of the human performance are established hierarchically.

Clear lines of authority and communication throughout the organization are established so that each individual is aware of his accountability and responsibility in ensuring nuclear safety.

The station management is responsible for establishing a safety culture that emphasizes to each individual engaged in an activity related to the safety of the plant the necessity for their personal commitment and accountability.

The management provides the necessary expectations, facilities and resources to support human performance. Examples of responsibilities of the management with regard to the improvement of human performance are given below:
- Clearly communicating performance expectation through meetings, policies and procedures;
- Emphasising the reasons behind the established safety practices and procedures, together with the consequences for safety of shortfalls in personal performance;
- Providing sufficient and proper facilities, tools and equipment, and support to the staff;
- Conducting self-assessments;
- Conducting field observations and coaching the personnel to use the best work practices.

In addition, for each level of management the specific level of authority is defined in the station Operating Policies and Principles (OP&P), the Nuclear Safety Policy and the Integrated Management Manual and detailed in other station procedures and documents, to ensure that individuals are aware of their responsibility and of the limits of their authority with regard to decision-making on safety issues.

12.2 Human Performance Program

The main objective of the Human Performance (HU) Program is to improve the behaviour of all personnel, including contractors, resulting in the safe and reliable station operation. Behaviours that contribute to excellence in human performance are reinforced to continually strive for event free operation.

Human Performance procedures, based on best industry standards have been produced to define the framework of the program and to support its implementation and continuous improvement. The status of the program is periodically reviewed, during regular meeting of the Human Performance Oversight Committee, chaired by Station Manager, and Human Performance Working Committee (HPWC) where station and department performance are reviewed, adverse trends are discussed and action taken to ensure consistent standards and expectations are adhered to across all departments. In addition, HU indicators and performance are reviewed at each department management review meeting to ensure performance meets expectation and corrective action is taken and ensure there is alignment between managers and supervisors.

The main components of the program are:

- Training (theoretical, skills and DLA);
- Observation and coaching;
- Use of Event Free Tools (EFT);
- Event and trend analysis;
- Communication of HU aspects.

Training

Station personnel as well as permanent contractors are included in the Human Performance training program, for familiarization with the terminology, the framework of the HP Program, the different aspects of using the EFT, the expected behaviours and the role of initiatives in the framework of the HP Program, according with their work within the organization.

Human Performance Training has been improved and extended to include classroom courses, practical “hands-on” (skills) and Dynamic Learning Activities (DLA). Training also is delivered to technical personnel with specific EFT for engineering activities.

Observation and Coaching

Using the Human Performance Program, several levels of managers and supervisors perform field observation and coaching.

The objectives of Observation and Coaching are to:

- emphasize the expectations with regard to behaviour and attitudes;
- correct work practices that are below the expected standards;
- identify and eliminate event precursors;
- obtain feedback from the employees in order to initiate improvements towards enhanced safety performance.

For the area being observed, the supervisor verifies the strengths and the aspects that need to be improved. After finishing the observation, the supervisor discusses the issues with the observed personnel and also reinforces the management expectations such as work quality, safety, conservative decision-making, reactor safety and public safety, depending on the involvement of the workers.

The adherence to the Observation and Coaching (O&C) program has been very strong by staff and supervision resulting in staff being more receptive to coaching. The quality of the O&C reports has also been improving as evidenced by station and department indicators. To record the positive aspects or the improvements identified, a web-based application for production activities was developed to help improve the O&C quality and the trend analysis, to include "paired observations", "coach the coach", "What It Looks Like" observation sheets or scheduled observations for operation and maintenance personnel. An application for engineering O&C was developed, to help technical staff record the O&C using specific Error Prevention Techniques for engineering activities.

Event Free Tools

The use of Event Free Tools (EFT) has been established at Cernavoda NPP, through which emphasis can be made on the reduction of events and errors. The EFT were implemented for all production activities (operation, maintenance, etc), and application of these techniques is a non-negotiable requirement for all staff, including contractors.

Event Free Tools (EFT):

A. Fundamental EFT:
- Situational awareness:
  - Task preview;
  - Two minutes rule;
  - STOP when unsure.
- Questionning attitude
- Self-checking (STAR – Stop Think Act Review)
- Procedure use and adherence
- Communication:
  - TWC (Three Way Communication);
  - Phonetic alphabet.
- Conservative decisions

B. Conditional EFT:
- Prejob Brief / Post Job Debrief
- Verification practices (concurent/ independent/ peer review)
- Flagging.

Supplementary, based on INPO 05-002 recommendations, Human Performance EFT for engineers and knowledge workers were developed, which are consistently applied in engineering activities:

Engineering Error Prevention Techniques (EPT):

A. Simple EPT
- Technical Task Prejob Brief
- DO NOT DISTURB sign

- Peer review
- Technical Task Turnover
- Technical Task Post Job Debrief

B. Complex EPT
- Validate assumptions
- Critical Analysis/ Questionning attitude
- Signature
- Effective communication and technical point of view support
- Validate assumptions

The use of the EFT is now embedded in the thinking process of plant personnel as well as permanent contractors. The implementation of human performance indicators demonstrates the improvement made and the acknowledgement of the usefulness of those tools by the staff.

Event and trend analysis

Human performance (HU) indicators were updated according to latest revision of INPO documents and COG Guideline “Leading Indicators for Human Performance”.

The performance indicators for the Human Performance Program are:
- Number of clock resets due to human error;
- Observation and Coaching Process Adherence;
- HU training courses passing rate;
- Self-reported ACR for HU errors;
- HU abnormal conditions rate;
- First causal factor incidence;
- HU events with consequences (direct impact);
- HU events with consequences (potential impact);
- Procedure adherence rate;
- Operation control configuration index – unit 1;
- Operation control configuration index – unit 2;
- Technical authority index – unit 0 + unit 1;
- Technical authority index – unit 2;
- HU events trend;
- HU events rate;
- HU program health report (composite indicator).

The degradation of the indicators is reported through the abnormal conditions process.

Trend analysis at the plant level is documented as an informative report which is distributed to all departments involved in human performance improvement program. Trend analysis presents the evolution of selected aspects over a period of 4 quarters (three quarters preceding the quarter reviewed and the analyzed quarter) in a graphic format. For the adverse trends of aspects identified during the O&C process, as well as for recurrent causal factors, a detailed analysis is performed, to identify the most correct causes and appropriate actions to improve. For trend analysis, the licensee uses the information recorded in the 'Observation and Coaching' database, in the 'Operating Experience' database and the 'EFD clock reset' application.

Trend analyses at department level are also performed to identify timely any possible performance degradation and to establish applicable measures that will prevent the performance at the plant level to be affected.

Communication of HU aspects

Focus of the month, Info Supervisor, INFOPLUS-HU bulletin constitutes additional means for good work practices and management expectations reinforcement.

The proposals for Focus of the month are analyzed during HPWC meetings based on the incidence of causal factors and performance indicators' trends. Once the subject is established, a written material, including relevant internal and external operating experience is submitted to working groups.

Currently a general subject is established, applicable for all station personnel and additionally there is a subject of the month for engineering personnel. Both "focus of the month" titles are posted on the front page of the daily planning meeting agenda.

Info Supervisor is a written material, issued at department level, used to inform the staff on topics that contribute to enhancing / improving performance for events occurred due to human error (experience internal and external) and lessons learned applicable to the department activities to prevent recurrence.

INFOPLUS-HU bulletin is a written material, issued at plant level, used to inform the plant staff about good catches, positive behaviours, issues or relevant information's about the HU program. A specific INFOPLUS-HU Bulletin is issued when EFD clock is reset at plant level.

Dissemination of the operating experience for the plant personnel is currently done via examples included in the work packages for various activities, pre-job briefings, daily meetings which focus on industrial safety, radiological protection and error prevention. Based on the lessons learned from the important plant and external events, materials "Training based on Operating Experience" are prepared and delivered regularly through the continuous training programs.

Similar with other stations, Cernavoda NPP developed a "rapid HU event analysis and communication" an instrument for a fast response when site and/or departmental "EFD Clock" is reset. This instrument is a versatile method to find what happened and to bring very fast the lessons learned to the workers.

12.3 Analysis of human errors

The Abnormal Condition Reporting program has been enhanced through replication of good practices from various benchmarking exercises and technical support missions. Self-assessments revealed that the majority of staff recognised the need for a comprehensive reporting program that included low-level event reporting.

Initiation of Abnormal Condition Reports (ACRs) for low-level events and near-misses determined an increased participation of plant staff into the process and resulted in a continuous increase of the number of ACRs. The mentality was smoothly shifted from reporting only significant events to report low-level occurrences.

Any deficiency in the practices or observed human error is immediately recorded and as appropriate an Abnormal Condition Report is issued for comprehensive evaluation and correction of the cause.

Systematic root cause analyses of the events based on the ASSET and HPES methodologies are conducted and the personnel from various compartments of the plant are involved in the performance of the necessary investigations.

The Human Performance Enhancement System methodology is a method to identify the various contributing factors and root causes of events that have been originated by human errors. The thoroughness with which an error or a human performance problem will be investigated and analyzed depends upon the perceived significance (e.g. safety, potential economic impact, etc.) of the event sequence in which the error occurred or the potential for harm that an adverse human performance trend presents.

In addition, the role of the error in an event sequence will also influence the extent to which an error is investigated. Factors that would be assessed would be work organization and planning, work practices, man-machine interfaces, work place factors and hazards, personal factors, but also organizational factors like resource management, change management and managerial methods.

Event and causal factors charts used in support of this analysis method identify all those contributors so that corrective actions can be developed to minimise recurrence of the same and similar problems.

Also, the events that had direct impact on nuclear safety, personal safety or production and have been directly caused by an inappropriate human act would reset the Event Free Clock, which is an indicator of the station human performance events.

More information regarding the investigation of events is provided under Article 19.

12.4 Consideration of human factors and the human - machine interface in the design

The design of the plant ensures that most regulation and control functions are automatic in order to reduce effort of the operating staff and the probability of human errors.

Automatic actuation of control or protection systems is provided to respond to equipment failure or human error which could cause a plant parameter to exceed normal operational limits or a safety system trip set point. The overall plant design and the specific design of protection systems ensure that operator intervention is only required in cases where there is sufficient time for the diagnosis of plant conditions and the determination and implementation of operator actions.

The design of the control room incorporated a strategic placement of the instrumentation and controls used in safety related operations and in accident management. Specific attention was provided to device grouping, layout, labelling and annunciation. Appropriate attention to human factors and man-machine interface concerns ensured that the information available in the control room is sufficient for the diagnosis of anticipated events or transients and for the assessment of the effects of any actions taken by the plant operators.

Most of the information related to the Nuclear Steam Plant (NSP) status and part of the Balance of Plant (BOP) side is provided to the operator via the two station control computers (DCCs). The BOP and Common Systems control and monitoring is achieved by a DCS (Distributed Control System) and the relevant alarms or control signals important for the safety of the plant are transferred from the DCS to the DCCs.

The functions of the Control Computer System are:

- Control / Monitoring;
- Alarm / Annunciation;
- Display / Data Recording.

The information important for the safety of the plant must remain available to the operators at all times so that they won't exclusively count on the control computers. Normal parameter limits exceeding and abnormal states of the equipment are annunciated to the MCR operator. Alarm windows located on the different MCR panels work simultaneously with the alarm messages given by the control computer system.

The operator in MCR is provided with all necessary information that allows a safe control of the plant for all operation modes, including for the cases when the dual computer system is lost and only conventional control devices remain available. In case of dual control computer system unavailability, the alarm windows become the sole source of annunciation. However, these are required for monitoring the safe shutdown of the plant, as fast shutdown is actuated in the event of dual control computer failure.

A Secondary Control Area (SCA) enables the operator to take all the necessary measures for maintaining the plant in a safe shutdown condition for the events in which the MCR would become unavailable.

The environmental conditions in the MCR are equivalent with those for an office. A radiation monitor is in place to prevent access contaminated personnel and equipment to the MCR area. In addition to these standard conditions, in order to maintain and extend them in case of emergency, functional isolation was provided to ensure MCR operating capability.

The access route from the MCR to the SCA, and related areas to which the operator must have access, are adequately qualified to be maintained for events causing the MCR to become unavailable. The systems that provide working/habitability conditions in SCA are designed to ensure adequate protection to the operator when he is in the SCA, against accidental radioactive releases. SCA is provided with ventilation/ air conditioning system, seismically qualified and independent from the other ventilation/air conditioning systems of the plant. Working/habitability conditions are maintained by conventional strainers, radiation shielding, portable equipment for monitoring the radiation level and portable breathing equipment, smoke and fire detectors, drinkable water and first aid equipment.

More detailed information on how the human factors are taken into account in the design is provided under Article 18.

12.5 Procedural aspects

The development of procedures considers both the correctness of the technical information provided, and the format in which the information needs to be organized and presented to the user in order to ensure a clear understanding and to minimize the potential for errors.

Technical aspects were built in the initial operating procedures, whereas the format was changed following INPO standards. Changes to the operating procedures are allowed respecting the rules established through station procedures and providing that the proposed change would have no appreciable impact on the validity of the documents supporting the operating license.

The types of procedures used for plant operation consist of Operating Manuals, Operating Manual Tests, Operating Instructions, Abnormal Plant Operating Procedures and other applicable procedures which describe different station activities associated with plant operation. The above procedures state the responsibilities, authorities, and the necessary steps to develop the operating documentation including methods for use.

Operating procedures (for both normal and abnormal conditions) and maintenance procedures provide detailed instructions for the completion of assigned tasks. The availability of accurate and clear information in the procedures minimizes the possibility for human error and supports the man-machine interfaces.

Controls in the main and secondary control rooms, and the associated Control Equipment Rooms, are only operated by, or under the direction of, authorized personnel, in accordance with the approved station procedures, distributed in accordance with the procedure for the control of documents and marked-up as Master copies. Effective use of communication protocols (3-way communications, phonetic alphabet) and operating personnel's familiarization with the operation of systems and the location of the system controls minimizes the chances of human errors.

The training and qualification programs, as well as the mentoring and coaching programs, ensure that the field operators can easily ascertain the status of an individual plant systems or equipment and perform the necessary tasks, in accordance with the approved procedures and work plans. System alignment verifications and post-maintenance testing are routinely performed to detect and correct human errors that may occur during system manipulation or maintenance.

Any work to be performed within the station is assessed and a work package is prepared. Based on station processes related to work evaluation, all information existing in the station OPEX database are reviewed and, as appropriate any concern or errors related to work practices or human errors are addressed within the work package and in pre-job briefing in order to avoid their recurrence. Also for human error that reset Error Free Day clock, a specific “just in time” material is prepared for the involved groups in order to avoid future occurrence of the same issue.

Any modifications to the plant SSCs, including to plant documentation, are done in accordance with written approved procedures which describe in detail the change control process. In order to ensure that all aspects related to safety, quality, environment, finances, etc. are taken into consideration when evaluating a modification, a control checklist is used for screening all requirements to be addressed. Factors directly linked to human performance and man-machine interface are included in the modification control review screen. Criteria are specified for classifying the modifications, and the potential for affecting human factors leads to the classification of a proposed modification as “major”, to ensure that comprehensive assessments are performed and that all the applicable requirements are met for all the stages of the implementation. Modifications classified as “major” are also submitted to CNCAN for review and approval.

Further information on the different categories of procedures is provided under Article 19.

12.6 Shift staffing

As required by the Law, the specific regulations and the license conditions, the nuclear power station must have on duty sufficient qualified operating staff at all times, to ensure that the station, whether running or in shutdown, is operated in a safe and reliable manner.

Shift staffing is defined by a Station Instruction which specifies the process of managing the activities of the operating shift crews (including responsibilities of the operators and maintenance shift personnel) and also specifies the number of persons required to be at station and their responsibilities to cover different situations. The various members of the shift crew shall have, besides their normal duties, responsibilities for responding to various abnormal events such as fire, personnel injury, etc. The shift personnel receive special training as required for these additional duties.

Shift staffing has been reassessed and revalidated in the period 2015 – 2016, based on new regulatory requirements issued after the Fukushima accident. An external company was hired to evaluate the ability of the minimum shift complement to respond to design basis and beyond design basis events. The shift staffing was tested for highly resource-intensive bounding scenarios. These exercises were used for the revalidation of the shift staffing as well as for identifying improvements with regard to resources allocation on shift.

Besides the shift personnel, an “on-call” list is at all time available for the Shift Supervisor. The list includes both the personnel nominated for technical and administrative problems, and member of the Command Unit for Emergency Situations (unit / site / general emergency).

12.7 Fitness for duty

Cernavoda NPP has regulations and station procedures which describe the fitness for duty policy and principles for all personnel. Fit-for-Duty definition involve workers reporting at work without being under influence of illegal drugs, or under influence of medical drugs that may affect their ability to focus and to perform duties as per job-description. Also, Fit-for-Duty involves workers being in good physical condition.

All NPP employees must be medically and psychologically examined according to the safety and health management system (as part of the integrated management system) and Human Resources station instructions. The main procedures setting requirements on the fitness for duty are as following:

- “SNN personnel code of conduct” (corporate level document)
- Station Instruction “Site access control”
- Departmental “Code of Conduct” documents
- “Shift Turnover” procedure.

These procedures and instructions contain responsibilities for:

Employees, who have the obligation to:

- manage their health in a manner that allows them to safely perform their job responsibilities.
- come to work fit for duty (without being under the influence of any substance such as drugs or alcohol) and perform their duties of the job in a safe, secure, productive, and effective manner during the entire time they are working
- notify their supervisors when they are not fit for duty and when they observe a co-worker acting in a manner that indicates the he or she may be unfit for duty.

Managers, who have the obligation to:

- observe the attendance, performance, and behaviour of the employees under their supervision.
- follow the specific plant procedures when an unusual behaviour is identified.

The compliance with the rules of the fitness for duty, as mentioned above, starts from the hiring process when the medical records, criminal records and psychological profiles are verified. During the employment period, periodical mandatory medical and psychological checks are performed with for the entire personnel. Same rules are applied for contactors. For workers with rheumatologic issues, Cernavoda NPP developed a special health recovery program. Also, as per International Health Organization recommendation, an influenza prevention program was implemented.

Preventive random checks for alcohol and drug intoxication are carried out as per station instruction “Site Access Control”. Annual evaluation of personnel performance is performed as per station instruction “Staffing and Staff Development”.

Regulatory requirements on fitness for duty, with focus on the control room operators, are stated in the “Regulation on granting practice permits to operating, management and specific training personnel of Nuclear Power Plants, Research Reactors and other Nuclear Installations”.

12.8 The Role of the Regulatory Authority Regarding Human Performance Issues

One of the roles of CNCAN is to ensure that the license holder adequately includes human factors in the design, assessment and operation of nuclear facilities. This role is accomplished by directly interacting with the license holder in activities related to design (including design changes) and modifications to procedures and processes. This is done through the normal process for review and assessment of safety documentation submitted by the license holder or applicant for a license, as well as through the regulatory audits and inspections.

The regulatory oversight exercised by CNCAN in the area of human and organizational factors covers the following:

- Human factors in design – consideration of human factors in design is reviewed as part of the regulatory assessment of design modifications for the existing nuclear installations (or as part of the regulatory assessment of the overall design, in case of a new reactor); consideration of human factors is reviewed also as part of the regulatory assessment of full-scope simulator fidelity;

- Human factors in safety analyses – considerations of human performance are reviewed as part of the regulatory assessment of deterministic and probabilistic safety analysis i.e. as regards:

- the assumptions made in the analyses regarding human actions,
- the time when they are performed,
- the probability of human error,
- the conditions in which the actions are to be performed,
- the training, qualification and validated procedures supporting these actions,
- the “habitability” analyses, etc.

- Human factors in procedures - procedures for normal operation as well as emergency operating procedures are subject to regulatory review and human factors considerations are part of the assessment e.g.:
    - format and style of the procedures,
    - place keeping,
    - compatibility with the number of staff and the environment in which they are to be used,
    - validation of operation and maintenance procedures,
    - validation of emergency operating procedures, including feasibility of various actions in different locations – Main Control Room, Secondary Control Area, local panels, etc., validation of minimum shift complement,
    - legibility of printed procedures, etc.

- Operational performance - human performance considerations are reviewed as part of the following activities:
    - the examination of control room and shift supervisors on the full-scope simulator, for licensing purposes;
    - the interview of plant managers, for licensing purposes;
    - the analysis of significant events which have human factors as a contributing cause;
    - the observation of various activities of the operating staff, such as shift-turnover, performance of testing and maintenance activities, training activities;
    - the assessment of training and qualification programs and procedures;
    - the assessment and inspection of human resources management (staffing, selection and recruitment, promotion, succession planning);
    - the assessment of organizational changes planning and implementation;
    - the implementation of fitness-for-duty.

- Emergency planning and preparedness - considerations of human factors are reviewed as part of the regulatory assessment and inspection of emergency response plans, procedures and arrangements; this includes:
    - use of lessons learned from major nuclear and industrial accidents to improve emergency arrangements;
    - observation activities during emergency response exercises;
    - use of experience from exercises to improve emergency response plans and procedures and emergency preparedness training.

- Organizational structure and staffing of the licensee – the regulatory reviews focus on:
    - the assessment of the staffing needs;
    - the procedures for recruitment and for training and qualification of staff;
    - licensees’ self-assessments on the sufficiency and adequacy of the staffing;

succession planning is also reviewed;
- staffing dynamics and trends;
- long-term planning of staffing;
- changes to the organizational structure or resources require regulatory approval before implementation and monitoring after the implementation.

- Management system and its processes – the management system manuals and procedures of the licensees, their management, core and support processes are reviewed, audited and inspected by CNCAN; the reviews cover the self-assessment and independent assessment processes, the use of operational experience feedback and the management of non-conformances and corrective actions.

- Safety conscious work environment – in 2015, CNCAN has issued explicit regulatory requirements on the licensees' obligation to encourage staff to report concerns without fear of repercussions/retaliation, to resolve such concerns and to provide feedback to the staff that raised the issues.

- Implementation of the nuclear safety policy – in 2015, CNCAN has issued explicit regulatory requirements on the establishment, communication, display and implementation of the nuclear safety policy.

- Implementation of the internal independent nuclear safety oversight – in 2015, CNCAN has issued new requirements on the independent nuclear safety oversight within licensees' organization ("internal regulator").

- Nuclear safety culture – the regulatory oversight of safety culture has been formalized in a Safety Culture Oversight Process (SCOP), with detailed guidance for the assessors and inspectors, based on the 37 safety culture attributes in the IAEA safety guides.

12.9 Summary of significant developments in the area of Human Performance

Cernavoda has continuously improved the communication of HU aspects which includes monthly bulletins, intranet site, HU booklets for staff and contractors. Also prior to the annual outages there is an increased focus on the need to reinforce EFTs and O&C during the execution of the work. Rapid trending and increased reporting is implemented during such periods of high activity.

The human performance training courses (classroom, practical training courses and Dynamic Learning Activities) have been extended with new courses, especially regarding practical human performance skills, in order to train plant personnel on human performance best practices and Event Free Tools.

Specific DLAs have been implemented in the period 2017 – 2018 for improving the performance in operational configuration control and risk management.

New operator consoles have been installed in 2016 – 2018 in the full-scope simulator and in the main control rooms of Units 1 and 2 of Cernavoda NPP. These modern consoles take account of the latest standards in human factors engineering.

An action plan is under implementation, starting with 2019, for enhancing Operation Fundamentals, to support continuous improvement of human performance in operating activities. The main actions are:

- Gap analyses on station documents and WANO/INPO documents related to Operator Fundamentals, to identify differences to excellence;
- DLA development for the operations staff related to operator fundamentals;
- Observations/Mentoring focused on the operator fundamentals in the Full-Scope Simulator, Main Control Room and in the field;
- Revision of PJB forms to be structured based on the operator fundamentals;
- Revision of the documentation to implement all the results from the previous gap analyses;
- Information of all the operating staff about the procedure changes related to operator fundamentals;
- An analysis of the opportunity to develop a PJB form specifically for the operating staff.

Efforts are on-going to establish specific leadership training for the operations personnel. External opportunities have been used systematically, such as courses offered through WANO and CANDU Owners Group (NPDS - Nuclear Professional Development Seminar). Actions are in progress to implement also a strong internal program for the systematic development of leaders with operational focus.

The developments in the area of personnel training, reported under Article 11, are also a significant contributor to the improvement of human performance.

ARTICLE 13 - QUALITY ASSURANCE

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programs 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.

13.1 Legislative and Regulatory Provisions

As required by the Law, any organization deploying activities important to nuclear safety shall establish Quality Management Systems (QMS) and shall submit an application to CNCAN for obtaining the relevant license.

In accordance with the provisions of article 24 of the Law, the QMS in the nuclear field for the design, siting, procurement, construction, installation, commissioning, operation, decommissioning or conservation phases of a nuclear installation are subject to licensing.

The licenses are granted by CNCAN in accordance with the provisions of the Law and the Romanian regulations on QMS. The conditions that the applicant has to meet in order to obtain a license, as stated in the law, are:

a) to demonstrate the professional qualification, for all job positions, of its own personnel, the personnel's knowledge of the nuclear safety requirements, as well as the probity of the personnel that have authority for decision making in managing the activities to be performed under the license;
b) to ensure that its own personnel involved in the activities to be performed under the license has the necessary knowledge and awareness of the impact that the deviations from the quality standards and specifications for the products and services supplied to nuclear installations would have with regard to nuclear safety;
c) to establish and maintain a controlled quality management system in its own activities, and to ensure that its suppliers of products and services, as well as their sub-contractors along the whole chain, establish and maintain controlled quality management systems.

All the above mentioned licensing conditions are further detailed and supplemented with specific requirements established through the set of regulations on QMS. The current Romanian regulations on QMS for nuclear installations and activities have been developed by CNCAN based on the Canadian Standards series N286 ed. 95 and Z299 ed. 85, ISO 9000/2000, IAEA 50-C/Q SG and the drafts of GS-R-3 and GS-G-3.1 (DS-338 and DS-339 from 2003).

The list of QMS regulations is given as follows:

1. Licensing of the quality management systems applied to the construction, operation and decommissioning of nuclear installations (NMC-01);
2. General requirements for quality management systems applied to the construction, operation and decommissioning of nuclear installations (NMC-02);
3. Specific requirements for the quality management systems applied to the evaluation and selection of the sites for nuclear installations (NMC-03);
4. Specific requirements for the quality management systems applied to the research and development activities in nuclear field (NMC-04);
5. Specific requirements for the quality management systems applied to the design of nuclear installations (NMC-05);

6. Specific requirements for the quality management systems applied to procurement activities for nuclear installations (NMC-06);
7. Specific requirements for the quality management systems applied to the manufacturing of products and the supply of services for nuclear installations (NMC-07);
8. Specific requirements for the quality management systems applied to the construction and assembling activities for nuclear installations (NMC-08);
9. Specific requirements for the quality management systems applied to commissioning activities for nuclear installations (NMC-09);
10. Specific requirements for the quality management systems applied to the operation of nuclear installations (NMC-10);
11. Specific requirements for the quality management systems applied to the decommissioning activities for nuclear installations (NMC-11);
12. Specific requirements for the quality management systems applied to the activities of producing and using software for research, design, analyses and calculations for nuclear installations (NMC-12);
13. Requirements for the establishment of classes for the graded application of the quality management system requirements for manufacturing of products and supply of services for nuclear installations (NMC-13).

The QMS of each participant in a nuclear project (owners, operators, contractors, suppliers, etc.) are developed and implemented in accordance with the provisions of the above mentioned regulations, providing an adequate framework to ensure that all activities important to nuclear safety are properly managed throughout the life of a nuclear installation.

13.2 Development of the integrated Management System for Cernavoda NPP

In accordance with the Law, the provisions of the regulations on QMS for nuclear installations (NMC series issued by CNCAN), the license conditions and the requirements of the SNN Quality Management Manual, Cernavoda NPP has established a Management System which integrates the requirements of regulations and standards applicable to nuclear and conventional industry, regarding nuclear safety, radiological protection, quality assurance, environment management, health and personal safety, physical protection and safeguards.

The integrated Management System currently in place builds upon the Quality Management System implemented in accordance with the CNCAN regulations and is aligned to the GS-R-3 standard issued by the IAEA.

The latest revision of the Cernavoda NPP’s Integrated Management Manual (IMM) has been issued in 2019 and has been approved by CNCAN. The structure of the document is mainly based on the IAEA GSR Part 2, IAEA GS-R3 and requirements of the ISO 14001/2015 EMAS (Eco-Management and Audit Scheme), ISO 17025 and OHSAS 18001 standards. The IMM describes the Management System applicable for the operation of Cernavoda NPP, and includes policies, principles and processes through which the organization’s mission and objectives are achieved.

13.3 Management Responsibility

To ensure the fulfilment of its mission to operate Cernavoda NPP in a safe and efficient manner, the licensee has established and implemented clear policies, in compliance with all the requirements deriving from the applicable laws, regulations, standards and other specific written requirements and dispositions issued by CNCAN.

All the organization policies in the field of nuclear safety, quality, environment, personnel health and safety are communicated to the personnel by training programs (initial and periodic knowledge refreshing) and by posting at working places.

The strategic plan of Cernavoda NPP is established for 5-year periods, with clear objectives in line with the station policies. Specific procedures have been developed describing how the strategic plan, goals and objectives are established and periodically re-assessed in order to ensure that the organization policy is adequately understood and implemented.

Management at all levels is responsible for the implementation of the Management System requirements. Senior management (the Site Manager) is ultimately responsible for the effective implementation of the management system requirements. Management expectations are clearly stated and supported by a comprehensive observation program which involves all managers and supervisors.

An independent Department for Developing and Monitoring Management Systems reporting to the Site Manager, is established and appropriately staffed for developing and monitoring the implementation of the Management System.

All documents developed under the Management System specify the management responsibilities related to the allocation of resources for the implementation and supervision of the addressed activities.

In order to ensure that adequate resources (human, financial, material, etc.) are allocated to implement and continuously improve the Management System, all station activities are grouped in basic and improvement programs. Each basic or improvement program is developed based on specific procedures and has a predefined structure. For each program an owner is assigned, who has the responsibility to establish the necessary human and material resources for implementation. Each program has a budget allocated, and the budget consumption is periodically reviewed and reported to the management level.

The amount of resources necessary to perform the activities of the organization and to establish, implement, assess and continually improve the management system is determined and provided by the senior management of the license holder, based on the assumptions made and needs identified by the programs' owners. The general information on the management of resources has been provided under Article 11.

13.4 Graded application of the Management System requirements

A graded approach is used for the implementation of the management system requirements, in accordance with the regulatory provisions which state that grading shall be reflected in:

a) the managerial level giving the approvals;
b) the extent of the managerial assessment;
c) the level of detailing and review of documents;
d) the extent and type of verifications;
e) the frequency and depth of audits;
f) the extent of surveillance;
g) the extent of requested corrective actions;

h) the extent of the records kept;
i) the type and content of personnel training / qualification requirements;
j) the extent of material traceability requirements;
k) establishing requirements for the records to be issued and for those to be kept for the entire lifetime of the nuclear installation;
l) the level of using independent verifications;
m) the degree of detailing of the process of identification, disposal and solving of non-conformances.

The regulations NMC-02 and NMC-13 contain detailed provisions for the establishment of quality classes for the graded application of the quality management system requirements, to ensure a consistent approach to grading for both the NPP and the suppliers of products and services.

In accordance with the regulatory provisions in force, nuclear safety significance (reflected in the safety class) is the first of the factors contributing to the assignment of the classes for graded application. Other factors taken into account include the complexity of the design and the difficulty in validating it; the complexity and difficulty of the execution process, the uniqueness or recentness of the product, service or process; the necessity of special processes, methods or equipment for verification or inspections; the difficulty of testing the functionality by inspections or testing after installation, necessity for personnel special training, economic considerations.

The graded approach is reflected in the procedures describing the different station processes. As an example, for the procurement processes a specific procedure is in place ("Graded Application of the Management System Requirements"), which describes the methodology for establishing the quality classes (four classes) for purchasing products and services. In accordance with the methodology given in the above mentioned procedure, for each product or activity a grade is assigned to each factor and a final score is then calculated, based on which the class is assigned. The contributing factors are of different weights, the nuclear safety significance being the most important.

Another example of grading is presented in the Corrective Action Process procedure, where the level of approval for closure is established based on the importance of the addressed issue. For example, if the addressed issue is a regulatory body concern, approval for closure is given by the Site Manager, while for an issue such as an improvement requirement the level of approval for closure can be limited to that of the direct superintendent/manager responsible.

13.5 Process Implementation

13.5.1 Management by process

All the activities at Cernavoda NPP are managed by processes. As a general rule, all the activities needed for / associated with the achievement of a certain outcome are constituted in a process and are accordingly planned and assessed to ensure that the expected results are obtained.

The hierarchical structure of Management System documentation is shown in Fig. 13.1. As observed from the figure, the documents defining processes are considered second tier documents, presenting a general description of the principles and structure of the process.

The list of Cernavoda NPP processes, grouped into three main categories, is given in Fig. 13.2, for exemplification. It should be noted that the list of processes is not frozen, new processes being introduced as the need arises. Most processes identified have already been defined (i.e. documented), while some are still under development, with the documentation in different stages of completion.

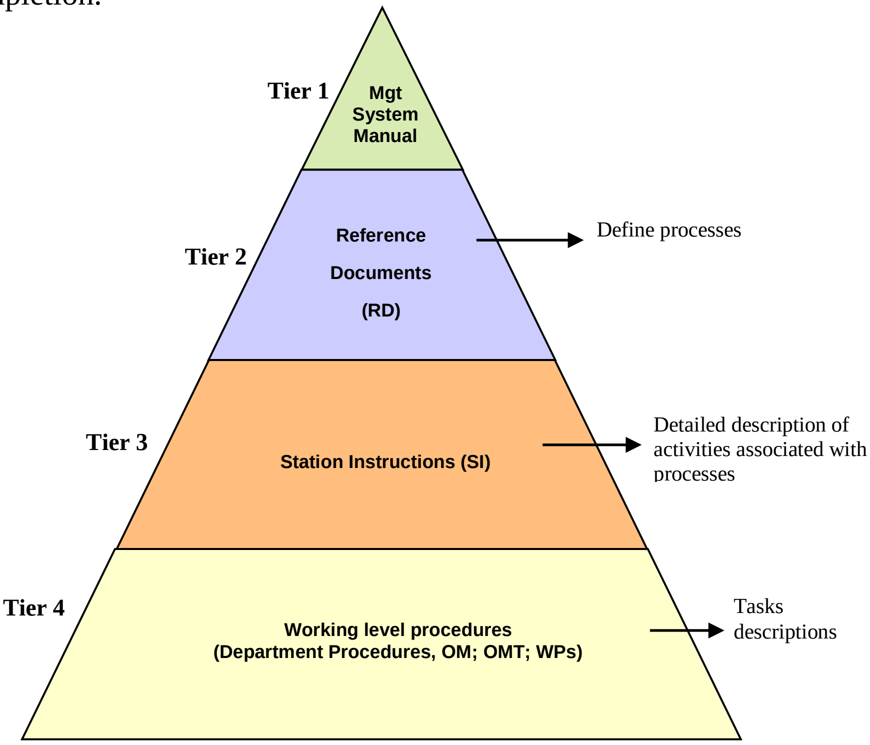


Fig. 13.1 - Structure of Management System documentation for Cernavoda NPP

13.5.2 Process ownership

For each process an individual is assigned as process owner, having the following responsibilities:

- establishing the process boundaries;
- developing the process procedures, diagram / flowchart;
- identifying the documentation that describes the activities within the process, evaluate it for completeness, ensure that it adequately reflects the process and maintain it up to date;
- identifying the interfaces with other processes;
- ensuring that the process meets all the applicable legal requirements, the latest standards provisions and that it reflects the plant objectives;
- establishing performance indicators for the process and for monitoring its efficiency;
- reporting on the performance of the process and promoting its improvement.

Clear procedures are established and define the individual responsibilities of those involved in the development, implementation and supervision of the activities and processes in such a manner that any conflict between responsibility and authority is avoided and that no undue delays in the performance of the work are introduced.

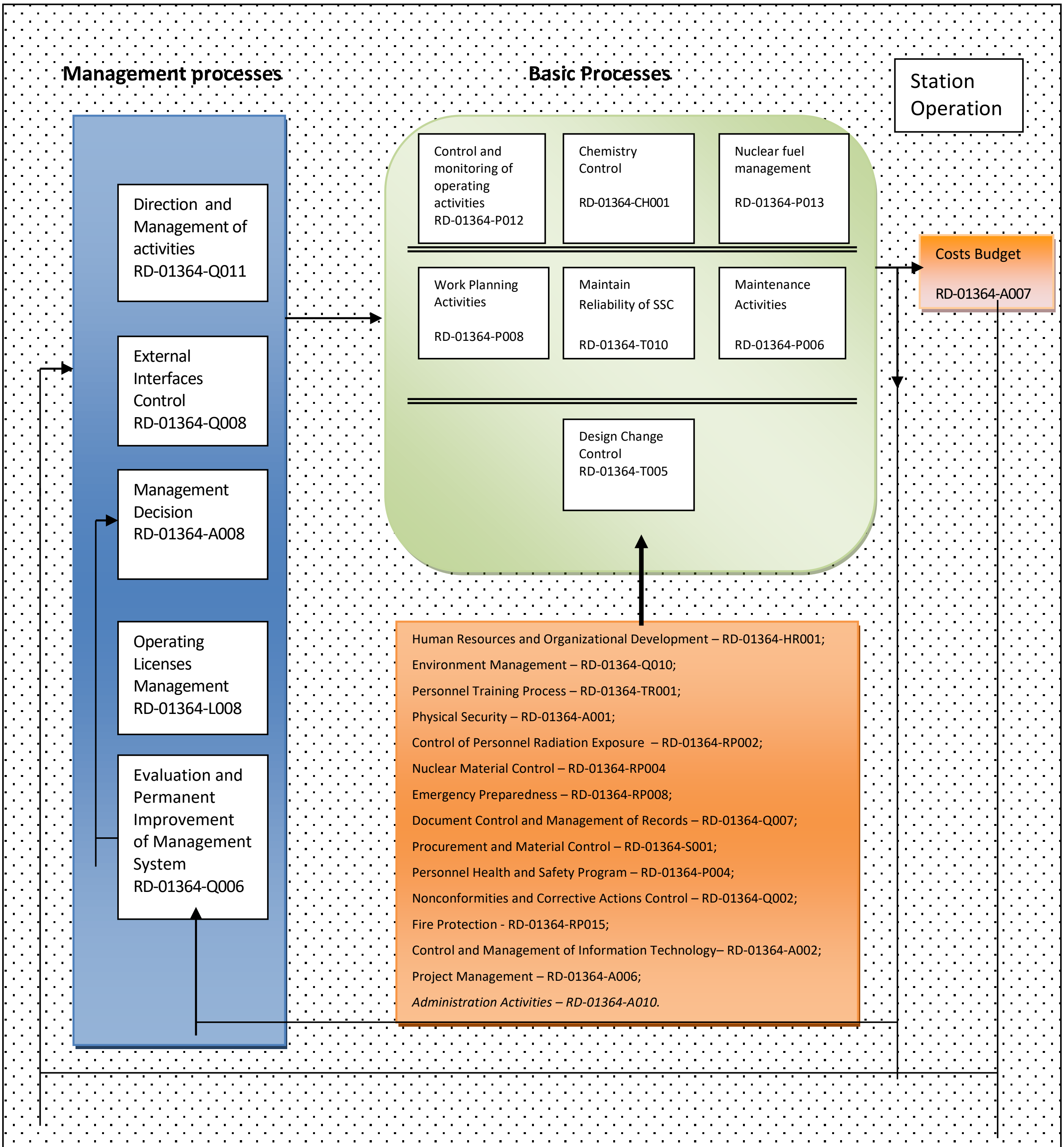


Fig. 13.2 Processes Map for Cernavoda NPP

When outsourcing is used for activities within the station, the contractor personnel are working under the direct supervision and control of plant staff and the activities are performed using station procedures and respecting the rules established by these procedures.

The operating organization retains overall responsibility when contracting any activity. Also specific training is provided for permanent contractors on site, similar with the training provided for plant personnel.

13.5.3 Management System Processes

Management processes: The managerial processes are considered as being the processes which define the managerial context. These processes are grouped into five reference documents and they each cover a separate field of activities.

The first process reference document - Direction and Management of activities RD-01364-Q011 describes the means of managing activities under separate processes and gives assistance to every person who has being given responsibility to control the activities under their scope.

The second process reference document - Management Decision RD-01364-A008 envelops the managerial decisions and provides assistance for improving the performance of personnel, states the principles for establishing strategies at Cernavoda NPP, sets out the long term plan for the nuclear station.

The third process reference document - Operating Licenses Management RD-01364-L008 describes the management of the operating licenses and the preparation for maintaining them in conformance with nuclear regulations and legal requests.

The fourth process reference document - External Interfaces Control RD-01364-Q008 considers the relationship that Cernavoda NPP has with external counterparts and also with nuclear regulators, pressure boundary Romanian authorities and therefore every organizational unit is made aware of their duties.

The fifth process from this group is developed in the reference document Evaluation and Permanent Improvement of Management System RD-01364-Q006, describing the evaluation and continuous improvement of the management system implemented at Cernavoda NPP.

Key processes: The key processes are set apart into 7 reference documents.

The first reference document - Control and monitoring of operating activities RD-01364-P012 gives a detailed account of the activities performed for controlling and monitoring the operation of the NPP. All the detailed activities are described in station instructions and process specific procedures for the shift operation personnel, standard operation sequence, abnormal plant operation procedures and many other operation explicit activities.

The second reference document - Chemistry Control RD-01364-CH001 covers the chemistry control mandatory for the operation of the nuclear power plant. With the same degree of importance this reference document establishes the requirements for controlling nonradioactive effluents and managing chemical synthetic compounds.

The third reference document - Nuclear fuel management RD-01364-P013 sets the requirements for all the activities related to the management of the nuclear fuel on Cernavoda NPP site.

The fourth reference document - Work Planning Activities RD-01364-P008 covers the process for planning work activities at Cernavoda NPP. Accordingly, every maintenance work – predictive, corrective, preventive, minor or others – inspections, non-destructive examinations are planned long before being performed. The planning process is made up of three sub-processes: 2 Year Look Ahead activities while the nuclear power plant is under operation, 13 Week Look Ahead Maintenance planning with the nuclear power plant in operation and the program of planned and unplanned outages.

The fifth reference document - Maintenance Activities RD-01364-P006 governs the maintenance activities at the nuclear plant. This process covers also the assessment of the work packages, their accomplishment and conclusion, order and housekeeping in the nuclear power station, activities deployed within pressurized vessels, measuring devices metrology at Cernavoda NPP and preventing foreign materials from entering nuclear power plant systems.

The sixth process reference document - Maintain Reliability of SSC RD-01364-T010 describes how to maintain the reliability of structures, systems, components and equipment at Cernavoda NPP. Therefore, there are included subsequent station instructions aiming for accomplish the same process as the plant life management, managing issues with noteworthy impact, monitoring components health status, monitoring and reporting operation risks and the performance of nuclear safety systems and also the mandatory testing program.

The seventh process reference document - Design Change Control RD-01364-T005 governs the design change control of the nuclear power plant and sets out the methods for the proper documentation, implementation, assessment and improvement. This process defines the design limits and the licensing while permanently maintaining the configuration between design and operation configurations. For this purpose, there are station instructions for operation instructions, jumpers record, station control computer software change control, processing design modification proposals, temporary design modifications.

Support processes: There are 16 reference documents covering support processes, as follows:

- Human Resources and Organizational Development – RD-01364-HR001;
- Environment Management – RD-01364-Q010;
- Personnel Training Process – RD-01364-TR001;
- Physical Security – RD-01364-A001;
- Control of Personnel Radiation Exposure – RD-01364-RP002;
- Nuclear Material Control – RD-01364-RP004;
- Emergency Preparedness – RD-01364-RP008;
- Document Control and Management of Records – RD-01364-Q007;
- Procurement and Material Control / Nuclear Supply Chain – RD-01364-S001;
- Personnel Health and Safety Program – RD-01364-P004;
- Nonconformities and Corrective Actions Control – RD-01364-Q002;
- Fire Protection - RD-01364-RP015;
- Control and Management of Information Technology– RD-01364-A002;
- Project Management – RD-01364-A006;
- Administration Activities – RD-01364-A010;

- Costs Budget RD-01364-A007.

13.6 Measurement, Assessment and Improvement

Several mechanisms are used to review the effectiveness of the Management System established and implemented at Cernavoda NPP and its continuous improvement.

The Management System evaluation process is defined in the procedure "Evaluation processes within Cernavoda NPP". In accordance with this procedure, three types of evaluation are used:
- Independent Assessments (audits, surveillance activities, external audits performed by different organizations e.g. SNN Audits, CNCAN audits, IAEA OSART Missions, WANO Peer Reviews, etc.);
- Self – Assessment of station processes;
- Management Reviews (Annual Management System Review, PSOC, etc.).

13.6.1 Monitoring and Measurement

For each program/process, appropriate performance indicators are established, which are periodically reviewed (monthly, quarterly, biannually or annually) and their results and trends are reported to the management. A colour code is allocated to each indicator and qualitative interpretation of the performance can be made. For indicators which have recorded a low value (e.g. yellow or red colour), assessments are performed to identify the causes and corrective actions are established aimed at improving the performance of the respective activity.

13.6.2 Self - assessment

Cernavoda NPP has established and implemented a self-assessment activity for continuously evaluating the performance processes of the plant. The criteria used in evaluating the performance have been established for each process based on WANO Performance Objectives and Criteria and OSART guides and standards, as well as on the internal reference documents and procedures of the station.

Self-assessments are periodically conducted to evaluate the activities and processes and identify opportunities for improvement and optimization. The actions resulted from these evaluations are included in the Corrective Actions Database.

The means for evaluating the performance of a process in meeting the established objectives and criteria, the responsibilities of the personnel involved in the process, the requirements for reporting of the results from self-assessments and for initiating improvement or corrective actions are described in the procedure "Self-assessment process at Cernavoda NPP".

13.6.3 Independent Assessment

According to the procedure "Evaluation processes within Cernavoda NPP", the independent assessments are categorized as:
- internal audits;
- external audits;
- peer reviews;
- technical reviews;
- surveillance of activities;

- nuclear safety assessment (performance assessments).

The internal audits are performed based on a plan approved by the Site Manager, accepted by SNN and approved by CNCAN. The planning of the internal audit activities is done in accordance with the station procedure for internal audits and inspections of the management system. The personnel of the audit team is qualified in accordance with the applicable regulations and standards and is not involved in any of the activities being assessed. As appropriate, specialists from different areas are involved in the audit teams in order to increase the efficiency of the audit. Specialists included in the audit team do not have any responsibilities involvement in the work performed in the audited areas. The leaders of the audit team are certified auditors.

Examples of areas subject to internal audits:
- the performances of the safety related structures, systems, equipment, components and software;
- the performance of the maintenance activities;
- the condition of the safety related SSCs and the implementation of the programs for testing and inspections;
- the development, review, use and updating of the management system documentation;
- the implementation of nuclear safety requirements and the safety culture;
- the activities related to personnel training;
- the implementation of the corrective actions and their efficiency.

The audits established through annual plans are supplemented, as necessary, for situations when there is a concern with regard to the quality of the results of a process/activity or to their efficiency, or when significant changes have been introduced in station processes.

A report is produced as a result of every internal audit and presented to plant management. The corrective and preventive actions or recommendations in the audit reports are introduced in the Corrective Actions Database and monitored through the Corrective Actions Process for the station. The internal audit reports are also made available to SNN and to CNCAN within two weeks from the completion of the audit.

The external audits are conducted at Cernavoda NPP by SNN Quality Management Department, by the regulatory authorities or by certification bodies. This category includes audits performed by CNCAN.

The peer reviews are conducted on specific areas by groups of internal or external experts, with the aim of identifying improvement opportunities and of promoting good practices. This category includes also the review missions by international organizations.

The technical reviews are independent assessments requested by the management. Their scope is to evaluate certain technical aspects of a process or activity, with focus on the identification of means for improvement. This type of reviews is described in the procedure “Information Reports”.

The surveillance of the activities is considered as the most suitable evaluation technique, being more flexible and requiring a lesser degree of formalism than the audits. It provides immediate feedback and detailed information on a specific activity or area of activities, being also used to monitor the implementation of observations/recommendations previously made.

Starting with the 1st of October 2016, a new group was formed, Nuclear Safety Independent Oversight (Performance Assessment), according to CNCAN regulation NSN-20 on Nuclear Safety Policy and Independent Nuclear Safety Oversight. From the October 2016 to October 2018 the group was in the administration of the Department for Developing and Monitoring Management Systems and was reporting to the Cernavoda NPP General Manager (CNO). After October 2018 the group has been moved in Cernavoda NPP Manger (SVP) and is reporting to SNN General Manager (CEO). The independent assessments are performed based on a plan approved by the SNN General Manager (CEO). The independent oversight personnel is licensed by CNCAN in accordance with the provisions of the regulation NSN-20.

External reviews are also valued as an important component of the independent assessment. In the period 2016-2019, a WANO Peer review and Follow-Up Mission, as well as an OSART evaluation and a Follow-Up have been held at Cernavoda NPP, confirming the excellent performance of the station and providing recommendations and suggestions for continuous improvement.

13.6.4 Management System Review

A process for periodic review of the MS by management is established and implemented, in accordance with the approved procedure “Evaluation processes within Cernavoda NPP”. The review takes in consideration the results of the audits, self-assessments, etc., and is oriented to find opportunities for improvements of the system. As a rule, the review is performed annually, although supplementary reviews can be performed after new processes are introduced, or in case that the efficiency in the implementation of the management system requirements is below expectations, in order to identify causes and initiate timely corrective actions.

The review includes aspects related to:

- the adequacy of the management system documentation for each area of activity;
- the fulfilment of the tasks having impact on safety related SSCs;
- the conformity with the license conditions and regulatory requirements;
- the fulfilment of the objectives and standards for training;
- the fulfilment of the objectives and standards for maintenance;
- the conformity with procurement standards for replacement of materials and components;
- the use of operating experience feedback;
- organizational issues such as levels of authority and responsibilities, internal and external interfaces, communication, etc.

For all the areas of activity, the review is focused on identifying results that fall short of the expectations and causes that contribute to and determine these results, and on establishing measures to correct deficiencies and improve performance.

The periodic review of management system efficiency does not substitute the normal processes for identifying and correcting deficiencies and is not intended to be used for performing detailed technical assessments or for the general evaluation of plant administration. Such processes are performed separately and provide input to the periodic review of the management system.

13.6.5 Non-conformances and corrective and preventive actions

The licensee has established and implemented a process for identification, reporting, analysis and control of materials, parts, or components which do not conform to requirements in order to prevent their inadvertent use or installation. This process include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification. Nonconforming items are reviewed and accepted, rejected, repaired or reworked in accordance with documented procedures.

Corrective/preventive actions are established and implemented in order to ensure that the cause of the abnormal condition is determined and corrective action is taken to preclude repetition or to avoid the occurrence. The corrective/preventive actions are entered for tracking in the Action Tracking database.

For each corrective/preventive action there is a responsible assigned and a deadline for implementation. Clear responsibilities are established for the implementation, monitoring the progress of the work, documenting the respective activities and verifying the efficiency of the corrective/ preventive action to provide assurance that its objectives are met. A non-conformance is closed when the solution is implemented and associated actions closed.

Periodically, the status of open corrective/preventive actions is reported to station management.

13.6.6 Improvement

The results from all the evaluations performed, as described in the previous sections, are used to identify opportunities for improvement of the station processes and of the management system as a whole, and to follow up on their implementation. As necessary, specific programs and projects are established when comprehensive improvement initiatives are undertaken, e.g. for Development of a Component Engineering Process, etc.

13.7 Regulatory Activities

According to the current licensing practice, each participant in a nuclear project has to demonstrate to the satisfaction of CNCAN the fulfilment of all the requirements of the applicable QMS regulations.

In the case of Cernavoda NPP, several review mechanisms are used by CNCAN to evaluate compliance with the legislative and regulatory requirements:

- assessment of the Integrated Management Manual and the conduct of comprehensive audits and inspections prior to granting the license for the respective phase of the nuclear installation;
- review and approval of the Management Manuals and a range of documents referenced in Management System Manual;
- evaluation and licensing of the personnel with major responsibilities in the establishment and development the Management Systems;
- the review of the arrangements for the quality assurance included in Chapter 17 of the Safety Analysis Report (PSAR or FSAR, depending on the stage in the lifetime of the installation);
- periodic audits, supplemented by inspections, to verify compliance with the licensing conditions and the arrangements made to ensure the continuous improvement of the

management system;
- audits and inspections for verifying licensee's arrangements for the contracted work;
- audits and inspections at the various suppliers of products and services for the nuclear installation, and at their sub-contractors, to verify compliance with the conditions of their respective licenses and with the provisions of the applicable regulations.

Regarding the Romanian practice of licensing contractors, there are currently over 100 companies that are licensed or authorized by CNCAN. If the items/services provided by a subcontractor are to be used for equipment / systems classified as safety-related, then the subcontractor shall be licensed/authorized by CNCAN. As appropriate, periodic audits are performed in order to check if the licensed/authorized suppliers and subcontractors maintain their capabilities and continue to meet the requirements of the applicable regulations. This approach is not considered as having the potential for diminishing the licensee's responsibility, as it only constitutes an additional mechanism to provide confidence that the specified requirements for all activities important to nuclear safety are satisfied. It should be noted that the QMS are licensed by CNCAN from the point of view of the arrangements for and impact on nuclear safety.

The QMS manuals describing the quality management systems implemented by suppliers and subcontractors have to be submitted to CNCAN for review and approval and a license/authorization from CNCAN is needed as a prerequisite for obtaining a contract for supplying products or services for the nuclear power plant. This however is not sufficient, as a supplier having a QMS licensed by CNCAN can still be rejected by the utility if the criteria used for the utility's own evaluation are not met.

Cernavoda NPP performs a comprehensive evaluation of the technical capabilities and of the QMS of any supplier, in accordance with the station procedure defining the procurement/purchasing process. Only the suppliers found acceptable are considered qualified to provide services for the utility. As appropriate, periodic audits are performed in order to check if the accepted suppliers and their subcontractors maintain their capabilities.

For each of the audits and inspections performed, at the NPP or at the various contractors, CNCAN staff produces detailed reports of the audit findings and forwards them to the license holders of the involved organizations. When deficiencies are observed, the license holders are notified and required to take corrective actions. Depending on the non-compliances identified, enforcement actions are also taken by CNCAN, in compliance with the provisions of the Law.

13.8 Significant developments for the last reporting period

The most important changes since the issuance of the last report are summarized as follows:

- Cernavoda NPP's position in NUPIC and CANPAC organizations has been further consolidated.
- A new revision of the Integrated Management System Manual (rev.12) aligned to GS-R-3, GSR Part 2, has been elaborated by Cernavoda NPP and submitted for CNCAN approval in 2019.
- In 2017 and 2019 new licensees for the Management System of CNE Cernavoda has been issued by CNCAN based on "Licensing of the quality management systems applied to the construction, operation and decommissioning of nuclear installations

(NMC-01)”

- In 2018 the Management System has been aligned to the ISO 14001 edition 2015.
- For the period 2016-2018, 10 process procedures have been revised and approved by the regulatory body.
- Since 2016 a new group was established, to independently assess nuclear safety aspects - the Independent Nuclear Safety Oversight Group, in conformance with the CNCAN regulation NSN-20 “Requirements on the Nuclear Safety Policy and Independent Nuclear Safety Oversight for Nuclear Installations”. The independent oversight personnel are authorized by CNCAN. The group is reporting to SNN General Director (CEO). The independent assessments are performed based on a plan approved by the SNN General Director (CEO).
- Starting with 2016, all the self-assessment procedures have been revised to reflect the assessment of the process as a whole. The approach was applied on all processes, some being assessed every semester, and some having an annual frequency for assessment.
- In the period 2016 - 2019, a WANO Peer review and Follow-Up Mission, as well as an OSART evaluation and a Follow-Up have been held at Cernavoda NPP, confirming the excellent performance of the station and providing recommendations and suggestions for continuous improvement.

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.

14.1 Regulatory requirements on assessment and verification of safety

A general description of the Romanian licensing system for nuclear installations Romania is provided in Article 7, while the more detailed aspects of the licensing process, including safety assessments and verifications, for the different stages of the lifetime of a nuclear power plant are discussed under the Articles 17, 18 and 19.

The regulatory requirements on the assessment and verification of safety are established mainly by the following regulations:

- Nuclear Safety Requirements on Design and Construction of NPPs (NSN-02);
- Requirements on Containment Systems for CANDU NPPs (NSN-12);
- Requirements on Shutdown Systems for CANDU NPPs (NSN-13);
- Requirements on Emergency Core Cooling Systems for CANDU NPPs (NSN-11);
- Requirements on Probabilistic Safety Assessment for NPPs (NSN-08);
- Requirements on Periodic Safety Review for NPPs (NSN-10);
- Fundamental Nuclear Safety Requirements for Nuclear Installations (NSN-21);
- Regulation on the Licensing of Nuclear Installations (NSN-22).

Relevant requirements for the assessment and verification of safety, for the different phases of a nuclear installation project, are included also in the set of regulations on Quality Management Systems for nuclear installations (NMC series, presented under Article 13) which contain provisions related to the quality assurance and safety of operation, maintenance, in-service inspection, testing, modifications, etc. The other regulations mentioned under Article 7 also contain requirements for the assessment and verification of safety for specific areas (e.g. fire protection, radiation protection, external hazards, etc.). As described under Article 7, additional regulatory requirements are also established as necessary based on applicable international standards, codes and guides.

The regulatory requirements also specify the criteria for quality and validation for both analyses and computer codes, in order to ensure adherence to current standards. Tools and methodologies used in the Safety Report have to be proven according to national and international practices, and validated against relevant test data and benchmark solutions. The list of codes used for safety analysis for all CANDU stations (the standard analysis tool set) is defined and maintained by the CANDU Owners Group and SNN, the license holder for Cernavoda NPP, is a member of this group.

14.2 Safety assessments for Cernavoda NPP

14.2.1 Background

For the purpose of safety assessment all major systems in CANDU reactors are categorised as “special safety systems”, “safety related systems” and “process systems”. All special safety systems are independent from all process systems and from each other. The CANDU safety philosophy is based on the concept of single/dual failures. “Single failure” is a failure of any process system which is required for the normal operation of the plant and “dual failure” represents a combination of the single failure events and a simultaneous failure or impairment of one of the special safety systems.

The requirements that shaped the CANDU safety philosophy and design established that a plant shall be designed and operated such that the single failure events and the dual failure events do not exceed a frequency of one per three years and one per three thousand years respectively. The probability for any significant release of radioactivity shall be less than 1E-7/year (for any individual sequence of events). In order to meet these targets, the unavailability of the special safety systems must be 1E-3/year, or less. The existence of two independent fast shutdown systems in CANDU reactors, each with an unavailability of less than 1E-3/year, allows the assumption that at least one will operate when called upon by a process failure. The CANDU design basis safety philosophy does not consider a triple failure, i.e. a coincident process system failure and unavailability of two special safety systems, which has a probability of less than 1E-7/year.

Safety analyses are performed to demonstrate to the regulatory body that dose limits for postulated accidents do not exceed targets and to show that other credible sequences of events would not lead to unacceptable consequences. The safety analyses also set the requirements for the special safety systems (shutdown systems, emergency core cooling system and containment system). For the purpose of the accident analyses, only those events for which the intervention of one or more of the special safety systems is required to prevent fuel failure or the release of radioactive material into the environment are considered. These are referred as serious process failures. Typically, events were grouped according to the process system where single failure is postulated to occur. These include the primary circuit, the steam and feed water system and the fuelling machine.

Coincident failure analysis is a systematic assessment of postulated dual failures. Each postulated process failure is systematically coupled with a failure of one of the special safety systems. Loss of the shutdown systems is excluded from required dual failure sequences because the design includes two independent shutdown systems which are each capable of shutting down the reactor.

A distinguishing feature of dual failure assessment is that the analysis of CANDU 6 reactors must show that:

- coolable core geometry is retained, even if the ECCS were to be impaired;
- radioactive releases are adequately prevented, even if the containment system were to be impaired.

The deterministic approach uses several generic assumptions which are applied in assessing the consequences resulting from the postulated accidents. These include the following:

- Reactor trip occurs at the second trip signal on the less effective shutdown system.
- Intervention by the operator is not credited during the first 15 minutes following the clear

and unambiguous indication that an initiating event has occurred and that operator action is required.
- Mitigating automatic action by process system response is not credited.
- Each special safety system is assumed to be in its minimum acceptable configuration.

As part of the compliance with more detailed regulatory guidelines, safety analysis must also prove reactor trip coverage, by demonstrating that there are two diverse trip parameters, wherever practicable, that are detected by the sensing and control logic of each shutdown system for each serious process failure.

The resulting radiation dose for both an individual at the site boundary and the surrounding population are derived for the events in the accidents analysis matrix. These must meet the guidelines which have been established by the regulatory body.

These analyses, together with the assumptions on which they are based, define the analyzed state or condition of the plant. As such, they identify the envelope within which the plant must be operated in order to assure consistency with the supporting accident analysis. This can place specific performance requirement in terms of capability and availability on station system, components and instrumentation. In general, these special requirements are translated into operating practice by the Operating Policies and Principles (OP&P) Reference Document, as well as the operating manuals, including the Impairments manual.

Another analytical technique that has been used for CANDU reactors is the Safety Design Matrix, for dealing with matters of interdependency, post-accident operation and actions requiring operator intervention. The safety design matrix contained a combination of fault trees and event trees. In a Safety Design Matrix (SDM), event sequences are developed starting with an initiating event and concluding with a stable plant condition in which an adequate heat sink for fuel cooling exists, or to an acceptable low event frequency. The event frequency is generated from fault trees prepared to identify the frequency of occurrence of different failure modes of a system.

The event sequences address reactor shutdown, both by regulating and shutdown system action, and adequacy of fuel cooling for all post-accident time frames. The assumptions used in the SDMs are not as conservative as those used in deterministic analyses. They also identify operator action over a large time scale and factor in a reliability model for the operator based on the quality of information he receives and stress he is exposed to. As a result, SDMs are a more realistic representation than the deterministic analyses of the consequences to a similar initiating event.

The SDMs originally developed by AECL for Point Lepreau Nuclear Generating Station have been reviewed against Cernavoda NPP Unit 1 design and issued as supporting documents for FSAR Chapter 15. The SDM studies which were developed for Cernavoda NPP Unit 1 are:

1) Containment Operation;
2) Moderator as a Heat Sink;
3) Loss of Shutdown Cooling;
4) Moderator and Shield Cooling System as a Heat Sink;
5) Reactor Building Flooding;
6) Operation Following an Earthquake;
7) Flooding in Turbine and Service Building;

8) Total Loss of Service Water;
9) Inadvertent Addition of Positive Reactivity;
10) Loss of Electrical Power;
11) Small LOCA and ECC Operation;
12) Large LOCA and ECC Operation;
13) Loss of Instrument Air;
14) Loss of Steam Generator as a Heat Sink;
15) Dual Computer Failure.

In conjunction with SDMs, detailed reliability analyses for the most significant safety related systems have been developed. The selected systems are continuously monitored and the reliability analyses yearly updated consequently. The following reliability analyses have been performed:

1) Reliability Analysis for Emergency Core Cooling System;
2) Reliability Analysis for Shutdown System No. 1;
3) Reliability Analysis for Shutdown System No. 2;
4) Reliability Analysis for Containment System;
5) Reliability Analysis for Emergency Power Supply System;
6) Reliability Analysis for Emergency Water Supply;
7) Reliability Analysis for Auxiliary Feedwater System;
8) Reliability Analysis for Reactor Regulating System (Stepback on Neutronic Parameters);
9) Reliability Analysis for Shutdown Cooling System;
10) Reliability Analysis for Class III Standby Diesel Generators;
11) Reliability Analysis for RSW -Backup Cooling Water System.

In addition to the deterministic analyses, Safety Design Matrices and Reliability Studies, probabilistic analyses have also been developed. Following CNCAN requirements, a PSA level 1 for the design was prepared and reviewed by IAEA through an IPERS mission (1995) and subsequently after implementation of the mission recommendations. The results of the design PSA came up with the recommendation to improve the design through a series of design changes that were implemented during commissioning phase.

Information on the deterministic analyses performed for Cernavoda NPP Units 1 and 2 and on the current status of the Safety Analysis Strategic Program and the PSA Program is provided in the following sections.

14.2.2 Deterministic safety assessments

The deterministic analyses, including the description of initiating events, event sequences, acceptance criteria, methodology, results and interpretation are provided in Chapter 15 of the FSAR.

For Cernavoda NPP Unit 1, the process systems failures analyzed include:

- loss of regulation - loss of reactivity control;
- LOCA events (large LOCA and small LOCA);
- single channel events (spontaneous pressure tube rupture, channel flow blockage, end-fitting failure, feeder stagnation break);
- fuelling machine events;
- pipe breaks in HT auxiliary systems;

- loss of off-site power (complete and partial loss of Class IV electrical power, single heat transport pump trip and seizure of a primary heat transport system main pump);
- loss of heat transport system pressure and inventory control (pressurization events and depressurization events);
- loss of secondary circuit pressure control (pressurization and depressurization events)
- feedwater events (feedwater line breaks outside or inside containment, loss of steam generator feedwater flow);
- steam main breaks outside or inside containment;
- steam generator tube failure
- multiple steam generator tubes failure.

The majority of the above mentioned process systems failures (initiating events) were analyzed for the case in which the ECCS and the containment subsystems are available, and also in combination with various failures/impairments to either ECCS or containment subsystems. Feedwater events and steam main breaks were also analyzed in combination with loss of Class IV power. Large LOCA and small LOCA events are analyzed also in combination with loss of off-site power and with impairments to either ECCS or containment system functions.

In the 2013 revision of FSAR, new categories of initiating events were included: moderator system events, end shield cooling system events, common mode events (design basis earthquake), initiating events originating from shutdown state (loss of normal shutdown state heat sink – shutdown cooling system and design basis earthquake) and severe accident analysis. Also, combinations of steam and feedwater system events with loss of class IV power (off-site power) were supplementary added.

For Cernavoda NPP Unit 2, the analyses provided in the Chapter 15 of the FSAR were grouped in sections dedicated to:

- Heat transport system LOCA events
- Heat transport system non-LOCA
- Steam and feedwater circuit events
- Moderator events
- Shield cooling events

The heat transport system LOCA section consists of large and small break analysis both with and without Class IV electrical power. Events that affect a single fuel channel resulting in a small break in the heat transport system are assessed separately. These events are: spontaneous pressure tube rupture, channel blockage leading to channel failure, complete failure of a channel end fitting leading to ejection of fuel from the channel, inlet feeder breaks.

Also included are single and multiple steam generator tube failures. Heat transport non-LOCA events analyzed are: complete and partial loss of Class IV electrical power, seizure of a single heat transport pump, loss of reactivity control and loss of heat transport system pressure and inventory control. Steam and feedwater circuit events include steam line breaks inside and outside containment, feedwater line breaks, loss of steam generator feedwater flow and loss of secondary circuit pressure control. Moderator and shield cooling system events include loss of flow, loss of heat sink and loss of inventory.

The initiating events (failures of the process systems) are also analyzed in combination with impairments to the emergency core cooling system or to the containment subsystems.

The following events are explicitly analyzed with a subsequent loss of Class IV power: large LOCA, small LOCA, steam line breaks and feedwater system events. The analysis of loss of Class IV power for small LOCA is applicable to the analysis of single channel events, which include pressure tube rupture, channel flow blockage, end fitting failure and feeder breaks.

The safety analyses for Unit 2 were based on the guidelines provided in the document “Requirements for the Safety Analysis of CANDU Nuclear Power Plants (C-6, June 1980, issued by AECB). Examples of safety analysis requirements introduced by C-6 that differ from previous practices are given as follows:

- a requirement for a systematic review for the identification of postulated initiating events;
- five event classes, replacing the two categories of single and dual failures;
- correlation of event classes with probability of occurrence and allowable release limit;
- more explicit consideration of combinations of postulated initiating events with failures of mitigating systems (not just the classical dual failures).

A Safety Analysis Strategic Program (PSAS) was developed by Cernavoda NPP Unit 1 and approved by CNCAN. The main objective of the Safety Analyses Strategic Program is to get a better definition of the plant safe envelope. Also, the program intended to create and develop a group that will be able to perform and re-evaluate the safety analyses results. The program purpose was to update, based on plant specific models and state of the art computer codes, the entire set of accident analyses included in the Cernavoda Unit 1 Safety Analyses Report. This program is also aimed at maintaining and developing site capabilities to deal with safety related operational issues and also generic safety issues.

The first step considered in the project was to develop plant specific models, to be used with the last version of the computer codes. As part of this stage, primary circuit and secondary side models have been developed. Specific models for single channel analyses have been developed. Specific models for containment and dose calculation were also developed. As part of this stage there were prepared, verified and approved a number of about 31 internal reports. Each report is focused on the description of the plant systems and components and of the models developed for each of these. The models have been tested with similar conditions and the results have been compared with available results.

After the preparation and approval of all these models, another set of reports have been prepared in order to present the methodology that will be used for safety analyses purposes. For each initiating event that has to be analyzed in detail, based on plant specific models, a specific report has been prepared. Once the methodology was prepared and approved, for each of these initiating events, the analysis of the initiating events has been started. A total number of 37 information reports have been prepared, verified and approved.

Under the PSAS program, Cernavoda NPP is currently revising the Unit 1 and Unit 2 design basis safety analyses, and Chapter 15 “Safety Analyses” of the U1 and U2 Final Safety Report will be updated accordingly, to reflect the new analyses.

As recommended by CNCAN in the regulatory guide GSN-02 (Guide on the independent verification of nuclear safety analyses and evaluations), the plant procedure that describes the safety analysis developing process was revised, to include specific steps for independent verification of the new elaborated safety analyses.

According to the CNCAN regulatory guide GSN-04 (Guide on the format and content of the final safety analysis report for nuclear power plants), new chapters that describe the Beyond Design Basis Accidents were included in the Unit 1 and Unit 2 Final Safety Reports.

14.2.3 Probabilistic safety assessments

Part of the Cernavoda NPP PSA Program, the development of Cernavoda NPP Level 1 PSA was completed in June 2007, for Unit 1, respectively in March 2008, for Unit 2. The core damage frequency calculated as part of Level 1 PSA study for Cernavoda includes contributions from Internal Events, Internal Fires, Internal Floods and Seismic Events, for plant full power operation and shutdown states.

The PSA Program developed for Cernavoda NPP covers the following objectives:
- To assess the level of plant safety and identify the most effective areas for improvements;
- To assess the level of safety and compare it with explicit and implicit standards;
- To assess the level of safety to assist day by day safe plant operation using the Risk Monitor.

The first stage of this program was the development of Level 1 PSA study for Cernavoda NPP Unit 1, started in September 2000. In September 2003, after the successful completion of a limited scope Internal Events PSA for full power operation, the second stage of the program started by addressing the impacts of Seismic Events, Internal Fire, Internal Flooding and High-Energy Line Breaks on Cernavoda Unit 1 core damage frequency. Together with the internal events analyzed in the first stage of the project, these hazards are considered to be the relevant contributors to the NPP operational risk at full power operation. The second stage was finished in January 2005.

In the period 2000 - 2005, several IAEA IPSART Missions for Cernavoda PSA Project Stage I and Stage II confirmed the validity of methods used and the results obtained from classical state-of-the-art base PSA point of view and provided recommendations to refine some hypotheses in the frame of future use of the model for risk monitoring and other PSA applications.

During 2005 - 2007, the scope of Cernavoda Unit 1 Level 1 PSA was extended considering the events initiated during shutdown operating modes. The CNE Cernavoda Unit 1 PSA model resulted after this stage was used in two directions:
- To identify potentially significant contributors to plant risk from events that occur during shutdown operation;
- To extend the Risk Monitor EOOS of CNE Unit 1 to include shutdown states operation in order to be used for risk evaluation of planned outages.

The detailed study for Level 1 PSA for Cernavoda NPP Unit 2 has been started in 2006 and has been completed with Internal Events (including Fires & Floods) and Seismic Events for all plant operating states in 2008.

In order to support operational decisions with input from probabilistic assessment, Risk Monitor applications are developed based on the plant specific PSA models, providing on-line / off-line users with friendly interface. Cernavoda NPP Risk Monitor computer program for monitoring safety is Equipment Out of Service (EOOS) developed by EPRI, commonly used in nuclear power plants.

For Unit 1, the EOOS Risk Monitor application was developed and implemented in 2006 for full power operation, respectively in 2008 for low power and shutdown states. For Unit 2, the EOOS Risk Monitor application was developed and implemented in 2008 for full power operation, respectively in 2009 for low power and shutdown states.

The Level 2 PSA for Cernavoda NPP has been completed in 2014. In terms of initiating events and plant states required to be covered, the Level 2 PSA, started in 2012, is consistent with the scope of the Level 1 PSA. It covers Internal Events (including internal fires, high energy line breaks and internal floods), Fire, Flood and Seismic Events. Full power, shutdown and transition states are covered at the same resolution level as already considered in the Level 1 PSA study.

The large off-site release frequencies (LRF) calculated per calendar year (taking into account the period of time that the unit is in each operating state) fulfill the safety goal target as recommended by IAEA, International Nuclear Safety Advisory Group, INSAG-12, *"Basic Safety Principles for Nuclear Power Plants"* 1999.

External hazards screening has been performed and the applicable external events for Cernavoda NPP site are under evaluation to support External Events PSA development.

As recommended by CNCAN in the regulatory guide GSN-02 (Guide on the independent verification of nuclear safety analyses and evaluations), the plant procedure that describes the development process of the PSA studies was revised to include specific steps for independent verification of the new elaborated documents.

14.3 Continued Monitoring of the Nuclear Power Plant

14.3.1 Assessment and verification of plant modifications

The regulatory requirements and plant procedures adequately cover both permanent and temporary modifications. In accordance with the current requirements, the number of simultaneous temporary modifications must be kept to a minimum. Also the period of a temporary modification is limited. Sometimes temporary modifications are used as an intermediate stage before implementing a permanent modification. The status of temporary modifications which might have an impact on plant's safety is at all times known by operating personnel and reported to the management of the plant.

According to station specific procedures, modifications are classified in three classes: major (corresponding to modifications in categories 1 and 2 as provided in the IAEA NS-G-2.3), minor (corresponding to category 3 in the safety guide) and commercial modification (modifications with no safety impact). As a result of application of an evaluation screening process the type and safety significance of the modification are determined.

After the initial assessment performed to categorize the modification, a more comprehensive assessment is undertaken for major modifications. The graded approach is used in establishing the extent of the assessment. For major modifications, all the safety aspects are considered in the assessments and a demonstration that all the relevant safety requirements are met must be submitted to CNCAN. The non-routine operations or tests are treated in the same way as a major change or as a temporary modification that may affect the safety envelope. All major and safety relevant modifications (permanent, as well as temporary) are submitted for approval to CNCAN.

The Operating License Conditions state that excepting the cases for which CNCAN is granting written approval, there shall be no modification, not even temporary, which might diminish the nuclear safety margins resulted from the accident analyses included in the Final Safety Analysis Report, especially to the Shutdown Systems No. 1 and 2, the Containment Systems, the Emergency Core Cooling System and any support system for the above mentioned systems. This applies also for any other safety-related system, which are referred to in the plant Reference Document “List of safety related systems”.

Cernavoda NPP Nuclear Safety Policy and OP&P documents state that safety review of procedures, analysis and design changes shall be completed before the work is started. To comply, a dedicated process for all work/activities or modifications other than routine operation and maintenance has been in place since the early commissioning phase and require the use of a work plan for the implementation of each activity.

The initiation of the process is done in accordance with the procedure “Configuration Change Determination”. As a result of application of an evaluation screening process the type and safety significance of the modification are determined.

The requirements for installation, inspection and testing are developed according to the procedure “Design Modification Implementation”.

All Deviations During Implementation (DDI) are subject for safety assessments and appropriate actions are taken considering the importance of the DDI:

- Major DDI that affects the conceptual solution of the design modification will require a revision of the conceptual solution (in compliance with the procedure “Modification Proposal and Approval Process”)
- Major DDI that has no effect on the conceptual solution of the design modification will require a revision of the detailed solution (in compliance with the procedure “Design Revision Package”)
- Minor DDI are accepted “as it is” (in compliance with the procedure “Design Revision Package”)

After the implementation steps are completed, the system is declared as “available for service” and modification is “closed out” (in compliance with the procedure “Modification Close-Out”). This means that the modification tests meet the safety and performance requirements and all affected documentation is updated and the personnel is trained.

14.3.2 Surveillance Programs

The Operating License Conditions require having in place a program for the continuous monitoring of the plant safety parameters. At Cernavoda NPP, the continued monitoring of the nuclear installation is carried out through the Surveillance Program. The purpose of the program is to verify that provisions made in the design for safe operation, which were verified during construction and commissioning phases, are maintained throughout the life of the plant.

At the same time, the program verifies that the safety margins are adequate and provide a high tolerance for anticipated operational occurrences, errors and malfunctions, and detect in time any deterioration that could results in an unsafe condition.

Also, as per Operating License Conditions, the compliance with the following reference documents and station instructions, prepared by the utility and approved by CNCAN, is mandatory: “Operating Policies and Principles”, “Management of the Maintenance Activities”, “Maintaining Systems, Structures and Component Reliability”, “Periodic Inspection Program”, “Mandatory Testing Program”, “Preventive Maintenance and Routine Administration”, “Plant Life Management”, “Predictive Maintenance”, “Preventive Maintenance”.

All the important input data and main assumptions used in deterministic/probabilistic analyses supporting the plant license were included in a comprehensive document Safety Analysis Data List (SADL). The document also identifies the corresponding design data together with the applicable design references. SADL are submitted to CNCAN as part of the licensing basis documentation.

The purpose of the SADL is to demonstrate that the specific design of the plant is compatible with the safety analyses. This objective is achieved if the data and assumptions used in the accident analyses are confirmed against the design data documented in the final design manuals (when applicable). Where achievable, the design data were confirmed by specific commissioning tests. In case of inconsistencies between the results of the commissioning tests and the safety analysis data/assumptions, then more in-depth assessments are provided to confirm adequate safety margin.

These data constitute the main acceptance criteria for continuous operation of the plant. As surveillance results are obtained, the person conducting the surveillance activity, according with specific work procedures, compares them with the acceptance criteria. If the results fall outside of tolerances, corrective actions are initiated, in accordance with appropriate work procedures. The surveillance program includes appropriate actions to be taken for postulated deviations from the acceptance criteria, based also on safety analyses.

Surveillance results are examined by appropriate qualified persons, to provide assurance that all results satisfy the acceptance criteria from safety analyses and also to analyze the result trends that may indicate equipment deterioration. Where the trends indicate an unsafe direction of safety performance and the corrective actions can solve the problem only for a short period of time, a modification of the configuration is the subject of a safety assessment. The surveillance results represent also the plant specific data that are used as input data for the periodic review of deterministic and probabilistic analyses.

The Surveillance Program for Cernavoda NPP is divided into the following activities/programs:

a) Monitoring of Plant Parameters and System Status

One of the basic management process implemented at Cernavoda NPP, developed using INPO guidelines, consists in the Equipment Reliability Process. The performance of the systems and components that were identified as critical, considering the nuclear safety or production impact, is monitored. The surveillance program results, documented in the System Monitoring Health Report (SMHR) and the Component Monitoring Health Report (CMHR), are used both for operational risk and for reliability evaluation, so playing an important role in work planning and in station decision making processes. Also, the safety related systems equipment performance monitoring are key inputs for the Plant Life Management Program (PLIM) and the major SSCs Life Cycle Plan. Therefore, the surveillance program ensures that items important to safety continue to perform in accordance with the original design assumptions and intent.

b) Mandatory Testing Program

Mandatory tests are developed in accordance with the reliability claims made within the probabilistic analyses of the safety related systems. The test results offer an overview of the "actual-past" unavailability of the standby safety systems and allow immediate corrective measures in the case the test failed.

c) Checking and Calibrating of Instrumentation

A calibration verification test is intended to check whether a known input to the instrument or channel gives the required output. Also, it verifies that the response times are within the specified limits. This activity gives the confidence in instrumentation indications and its associated response time.

d) In-Service Inspection Program

The document which establishes the framework for the Inaugural and Periodic Inspection Program of NPP Cernavoda Unit 1 and Unit 2 is the Periodic Inspection Program Document (PIPD) based on the Canadian standard CAN/CSA N285.4 – 94: Periodic Inspection of CANDU Nuclear Power Plant Components.

Industry and own operating experience was used to upgrade the Periodic Inspection Program:

- Feeders inspection requirements changed to address possible damages observed in other CANDU stations;
- Steam Generators were modified to allow proper inspection;
- Piping inspection program upgraded using “CHECKWORKS™” software.

Cernavoda NPP obtained the regulatory approval and will improve the Periodic Inspection Program, by implementing the 2009 edition, with Addendums 2010, 2011, requirements of the standard CAN/CSA N285.4.

e) Preventive and Predictive Maintenance Program

The objective of preventive maintenance (PM) is to prevent equipment breakdown through a planned program of activities in order to ensure continued availability for service. The objective of the plant predictive maintenance program is to improve plant safety and reliability through early detection and diagnosis of equipment problems and degradation prior to equipment failure. This activity is based on monitoring the health of the system and associated equipment, measuring and analyzing trends of critical performance parameters.

A strong and technically sound maintenance program for critical equipment was fully implemented at Cernavoda NPP using EPRI (Electric Power Research Institute -USA) guidelines. Supporting predictive programs (vibration measurements, oil analysis, ultrasound detection, thermography, etc.) were also developed. Systematic collection of equipment ‘as-found' data, industry and station OPEX is used for continuous monitoring of program's performance.

Considering the WANO and AIEA recommendations, the required actions have been taken to prevent suspect, counterfeit or fraudulent items usage in Cernavoda nuclear facilities and activities, such as procurement quality surveillance, staff training and procedural barriers.

f) Ageing Management Program

Cernavoda NPP Overall Ageing Management Program integrates Plant Life Management (PLiM) Program, Preventive / Predictive Maintenance Programs, Testing and In-Service Inspection, Proactive Obsolescence Program, Environmental Qualification Program and System Surveillance/Health Monitoring Programs. In this way, the Overall Ageing Management Program integrates all aspects regarding ageing degradation control, implemented through different technical programs and processes developed in the plant. The purpose of this program is to maintain the performance in acceptable limits of critical Systems Structures and Components (SSC), throughout the plant life, based on implementation of several long term technical programs, aligned with international best practices and lessons learned in ageing management.

Cernavoda NPP joined the COG R&D programs in order to ensure strong technical basis for the station PLiM. Specific PLiM programs have been developed, with AIEA support, and submitted to the regulator, and life assessment studies are conducted, for relevant components, that allow the evaluation of components' actual condition from the perspective of long term operation of the plant.

Using the experience gained and benchmark missions to other nuclear facilities, the corresponding reference documents and station instructions were revised and the Overall Ageing Management Program was documented, to sustain the integrated approach to control ageing of all critical SSCs via technical programs and processes developed at Cernavoda NPP, not only for major plant assets, managed through PLiM Programs.

g) Systematic assessment of Critical Spare Parts Program

The critical spare parts inventory was revised based on the findings of equipment failure mechanisms analysis. Also, a shelf life program for spare parts was implemented.

14.3.3 Implementation and use of Risk Monitor (EOOS)

A risk monitoring program has been developed based on the existing PSA model and Equipment Out of Service (EOOS) software developed by DS&S as an EPRI contractor.

The PSA model has been built as a master fault tree F/T that includes the failure logic for all the accident sequences ending in a Core Damage State. The logic model development fully exploits the advance techniques and features available in CAFTA environment. Mainly those techniques involve use of a limited number logic flags, inclusion of initiating events identifiers inside the system F/T top events to simulate the initiating event's impact on different equipment, trains or systems, restructure the input logic in order to allow the quantification engine to work faster while generating the minimal cut-sets for all initiating events in a single run.

The next step in building the risk monitor model was to replicate the failure logic existing in the base PSA and introduce configuration flags inside the master logic F/T in order to account for any unit operating state (full power, intermediate power levels or shutdown state) or active equipment can be at a particular moment in time (ON/AUTO/STBY/OFF).

Mapping the relevant conditions, logic flags and basic events modelled in PSA to the corresponding equipment and constructing the panel interface were subsequent steps required to translate the PSA specific language to the operator's and scheduler language.

The following specific features provided by the Risk Monitor developed for Cernavoda NPP have to be emphasized:

- Dynamic recalculation of some initiating events frequencies based on the IEs F/Ts re-evaluation.
- Ability to increase the frequency of LOOP and General Transient by a factor to simulate the most credible impact of some conditions (e.g. external events, weather related) which are not explicitly included in the PSA.
- Ability to check equipment misalignments based on F/T supporting logic.
- Ability to recalculate the failure probability of the most significant standby equipment based on equations that consider the time elapsed from the last test.
- Ability to identify and prioritize the operator actions to reduce the risk based on the importance measures (RRW for the equipment out of service show what equipment are worth to be returned in service and RIR for the in service equipment show what equipment are worth to be protected or their failure probability to be reduced).

The risk thresholds have been defined by splitting the CDF variation interval in four regions. Two reference values have been used: the base CDF (the PSA value while setting up maintenance unavailability to zero) and the maximum acceptable CDF value (average PSA value). Each risk region is represented by a color consistent with those used in the Significance Determination Process colors:

- Green (Insignificant Risk Increase) – No actions required in respect with the risk management.
- White (Moderate Risk Increase) – Limit the duration. Evaluate the importance of OOS and I/S equipment and do not approve any work resulting in a higher action level. Inform Shift Supervisor.
- Yellow (Significant Risk Increase) – Same action as for White plus: Allocate all available resources to return in service the most risk significant equipment. Define and implement compensatory measures. Inform the Production and Safety Managers.
- Red (Unacceptable Risk Increase) – Same measures as for Yellow plus: Request for extra resources. Inform the Station Manager and initiate a Technical Operability Evaluation meeting.

As per EOOS results recorded from Cernavoda NPP two units cumulative operating experience of more than 24 years there were no instances to operate in Red risk region. In two instances were recorded short transitions of Unit 2 operational risk from White to Yellow risk region due to dormant failure of one Class III Standby Diesel Generator while the other Class III Standby Diesel Generator was unavailable for scheduled maintenance and testing, leading to 6kV Class III system unavailability for 2.2 hours and the other instance last for 4.5 hours due to meteorological Red code warning for blizzard and dormant failure of one Class III Standby Diesel Generator.

An updating and configuration control process is in place to ensure that the following types of modifications are identified on a day by day plant operation review and their impact on risk is considered: permanent/temporary configuration changes, hardware changes, changes to the plant operating procedures or maintenance procedures, changes to the component unavailability data as a result of the plant specific reliability data collection program.

Internal department procedures have been developed in order to define how the risk monitor is to be used by three categories of users:

- Main Control Room – keep the risk monitor updated with all relevant plant operating configurations, use the risk color thresholds to support mitigating actions;
- Planning Department – 13 weeks (E-13) schedules evaluation up to E-5 / E-2 / E-1 and E-0 execution week;
- Safety & Compliance Department – Safety Cases Evaluation (check list to be used by R&R engineers), allowed configuration time (ACT) assessment and compensatory measures for risk reduction (based on cumulative risk increases thresholds), outage scheduling, CDF monitoring and reporting on the monthly safety performance indicators, quarterly Plant Safety Oversight Committee meetings and QTR reports, EOOS users training.

The feedback from the users is being used to refine and improve the PSA model and to optimise the process for providing meaningful insights in support of the day by day operational decision making. After several years of EOOS Risk Monitor usage the plant personnel become aware on how PSA applications can support their activities.

14.3.4 Periodic Safety Review

In the past, the Romanian licensing system required a safety review to be carried every two years by Cernavoda NPP Unit 1, in order to support the license renewal. The main safety issues addressed, with the current Safety Analysis Report as the main document under review, corresponded largely to the 14 safety factors proposed by IAEA's Safety Guide NS-G-2.10. The scope of the Periodic Safety Reviews in the general understanding being more comprehensive, the benefit of carrying such reviews was recognized and this has led to a change in the Romanian licensing approach.

In 2006, following a recommendation received from an IRRS Mission organized by IAEA and also as a result of the participation in the study "Harmonization of Reactor Safety in WENRA Countries", CNCAN issued a regulation on Periodic Safety Review of Nuclear Power Plants, as a first step towards the changing of the licensing system. The regulation requires a PSR to be conducted every ten years. The Romanian regulation is based on the Safety Guide NS-G-2.10, having the 14 "safety factors" defined as "areas of review", for each of these having specified most of the "generic review elements" given in the Appendix to the IAEA guide.

In 2005, CNE Cernavoda started for Unit 1 the preparation phase of PSR using the IAEA Safety Guide, and also CNCAN regulations on PSR when they issued in 2006.

The main objectives of the Cernavoda Unit 1 PSR were the following:

- To undertake a systematic review of the current plant design and safety analysis against internationally accepted safety standards, codes and practices.
- To review ageing mechanisms and their management, in order to confirm that the plant is safe to operate for at least the next 10-year period, subject to continuing routine maintenance, testing, monitoring and inspection.

- To review the operating history of the plant, and plants of similar design, to identify and evaluate factors that could limit safe operation during the next 10-year period.
- To identify PSR Findings of safety significance, and determine those safety enhancements which are reasonably practicable, and that should be implemented as Corrective Actions to resolve the issues that have been identified.

The scope of the Cernavoda PSR was to cover all the 14 safety factors recommended by the IAEA and required by CNCAN.

As per national and international recommendations, the Cernavoda PSR project has been split into three phases:

Phase 1 - Project Set-up and Planning

The Phase 1 represents the initial set-up phase when the PSR scope, review criteria, program, quality arrangements, documentation plan, and project organization requirements were identified.

PSR Phase 1 of Cernavoda NPP Unit 1 was completed in 2007, when CNCAN approved the scope and program of the PSR for Cernavoda NPP Unit1, together with the Quality Assurance Plan.

Phase 2 – Main PSR Activities

The Phase 2 represents the main activity of the PSR, covering the review of the safety of all aspects of the plant. It was assessed the safety performance during the first ten years of operation, up to May 1, 2008.

This phase has been undertaken between May 1, 2008 and June 30, 2012. As a first step, a preliminary analysis has been done and documented in 6 Discipline Based Reports (DRs) and 39 Topic Reports (TRs) that constitute the primary low level documentation. The consolidated, systematic safety review has been further completed as the next step.

The PSR results were documented in 4 Information Reports, as follows:
- Main Chapter 1 – Summary of Periodic Safety Review
- Main Chapter 2 – Operational and Safety Performance
- Main Chapter 3 – Systems, Structures and Components
- Main Chapter 4 – Safety Analysis

Phase 3 – Corrective Action Plan & Implementation

The Phase 3 of PSR includes the analyses of identified safety issues and the development of the detailed proposals for the implementation of the corrective actions and/ or safety improvements to address the PSR Findings.

During the Phase 3, for each of the Findings identified in PSR and summarized in the Main Chapter 1, an analysis has been performed, that includes the final assessment of the safety impact of the finding. The final assessment considered what was done already between May 1, 2008 and June 30, 2012 and what had to be done to correct the problem. These analyses included also the final proposal of the corrective actions and were used as an intermediate steep for the development of the PSR Corrective Action Plan (CAP). A number of 37 corrective actions and improvements have been identified and included in the PSR Corrective Action Plan together with the proposed target dates for implementation.

In accordance with the national regulations, the results of Unit 1 PSR and the Corrective Actions Plan were submitted to CNCAN for approval. As a result of the review performed by CNCAN, 4 corrective actions have been added to the Corrective Actions Plan.

Up to date, 39 out of 41 of the total number of corrective actions resulted from the PSR have been implemented. The last 2 PSR findings are progressing towards completion and refer to the following:

- Revising the Chapter 2 “Site Characteristics” of the U1 and U2 Final Safety Analysis Report with the updated information gathered under the systematic reassessment of the external hazards applicable for Cernavoda NPP site;
- Implementing a design change that will improve the Main Control Room habitability during severe accidents, that is approved by CNCAN and included in the plant implementation program.

Further, Cernavoda NPP has performed an analysis of the applicability of Unit 1 PSR results on Unit 2, submitted to CNCAN as licensing support document.

The deficiencies identified through PSR, the corrective actions, the target dates proposed for implementation and the analysis of the impact of Unit 1 PSR results on Unit 2 were considered adequate by CNCAN.

After PSR completion, the main licensing document - Unit 1 Final Safety Analysis Report (FSAR) - has been updated and submitted to CNCAN, in order to support the Operating License Application.

Based on PSR results and on U1& U2 FSARs, in May 2013 CNCAN granted new licenses: for Unit 1 for 10 years and for Unit 2 for 7 years.

As required by the PSR specific national regulation and by the U1&U2 licenses provisions, Cernavoda NPP is currently performing the second PSR evaluation of the Unit 1 and the first PSR review for the Unit 2.

14.4 Description of the regulatory review process

Complex technical assessments/evaluations are performed by CNCAN staff when reviewing safety documentation (Safety Analysis Report and the supporting technical documentation) submitted in support of license applications. Technical evaluations are also performed for event analyses and when approving operation documentation. Other types of evaluation (inspections, audits, etc.) are described in the chapter corresponding to Article 7.

The main responsibilities of CNCAN staff performing safety assessment activities are:

- To determine whether the conceptual design is safe and meets applicable regulatory criteria;
- To determine whether the operating envelope is consistent with safety requirements, including regulatory requirements;

- Perform evaluations of the proposed plant modifications;
- Provide the basis for the decision of issuing licenses and approvals.

Safety evaluations of the safety documentation include the review of deterministic analyses, probabilistic analyses and reliability analyses.

The review and assessment performed by CNCAN as part of the licensing process and as part of the continuous regulatory oversight focuses on:

- Operating license renewal documents, including updates to the FSARs;
- New or updated safety analyses performed by the licensee;
- Resulting of periodic safety reviews (PSR or other more frequent routine reviews);
- Station safety performance;
- Significant events reported by the licensee;
- Temporary configuration changes;
- Plant modifications.

The review and assessment activities aim at verifying compliance with the following:

- Regulatory requirements, safety principles and design criteria;
- Defense in depth concept achievement;
- Systems separation philosophy;
- Special safety systems design requirements;
- Design codes, standards and safety guides.

The review and assessment activities are performed with the objectives of determining whether the applicable safety objectives and requirements for each aspect or topic have been met, whether the safety analyses cover both normal and fault conditions and whether the safety submissions provided are sufficiently complete, detailed and accurate.

14.5 Safety Reviews post-Fukushima:

The safety reassessments conducted in response to the Fukushima accident included the "stress tests" review required by the European Council for all the European nuclear power plants, in compliance with the specifications and criteria issued by the European Commission, based on the work done by the European Nuclear Safety Regulators' Group (ENSREG) and the Western European Nuclear Regulators' Association (WENRA).

These safety reassessments include:

- review of the safety margins for extreme external events;
- analysis of loss of electrical power and loss of ultimate heat sink accident scenarios;
- severe accident analyses.

The results of these reassessments have been extensively presented in the National Report of Romania for the 2nd Extraordinary Meeting under the Convention on Nuclear Safety (May 2012) http://www.cncan.ro/assets/Informatii-Publice/06-Rapoarte/RO-National-Report-for-2nd-Extraordinary-Meeting-under-CNS-May2012-doc.pdf.

The regulatory reviews performed on the implementation of the “stress tests” have focused on verification of the completeness and validity of the reports submitted and claims made by the licensee. Numerous on-site inspections have been performed to assess the progress of improvement actions resulted from the stress tests. All the design changes associated with the improvements proposed (and outlined in Annex 2 of this report) have been subject to CNCAN review and approval.

14.6 Significant developments for the last reporting period

Cernavoda NPP is performing a systematic plant global safety evaluation through the Periodic Safety Review (PSR) Program. Currently, the second PSR evaluation of the Unit 1 and the first PSR review for the Unit 2 have been commenced.

Under its Safety Analysis Strategic Program, Cernavoda NPP is currently revising the Unit 1 and Unit 2 design basis safety analyses and Chapter 15 “Safety Analyses” of the U1 and U2 Final Safety Report will be updated accordingly, to reflect the new analyses. This is performed in accordance with the regulatory requirements for reviewing and revising periodically the safety analyses to take account of new relevant information from operating experience, research and development activities.

In accordance with the regulatory guidance issued by CNCAN on independent verification of nuclear safety analyses and evaluations, Cernavoda NPP revised its procedures for the development and verification of deterministic safety analyses and probabilistic safety and probabilistic safety assessments.

Cernavoda NPP has supplemented the Final Safety Analysis Reports for Unit 1 and Unit 2 with new chapters, addressing the analysis of beyond design basis accidents, including severe accident analyses, in accordance with the latest regulatory guidance issued by CNCAN on the format and content of FSAR.

The regulatory developments with regard to issuing new requirements and guidance relevant for the assessment and verification of safety have been presented in the chapter corresponding to article 7.

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.

15.1 Regulatory framework for radiation protection for Nuclear Power Plants

In accordance with the provisions of the Law, CNCAN is empowered to issue regulations for the detailed specification of the general requirements on the protection against ionizing radiation and to control their implementation.

In this respect, CNCAN has issued a number of regulations regarding the radiological safety of nuclear and radiological installations, the following being the most important ones applicable to nuclear power plants:

- Basic Requirements on Radiological Safety;
- Requirements on Individual Dosimetry;
- Requirements for Limiting Radioactive Discharges into the Environment;
- Requirements for the Monitoring of Radioactive Emissions from Nuclear and Radiological Installations;
- Requirements for the Environmental Radioactivity Monitoring around Nuclear and Radiological Installations;
- Requirements for the Calculation of Dispersion of Radioactive Effluents, Discharged into the Environment by the Nuclear Installations;
- Requirements for the Meteorological and Hydrological Measurements at Nuclear Installations;
- Requirements on the Issuance of Practice Permits for Nuclear Activities and the Designation of-Radioprotection Experts.

The other national authorities involved in the licensing process, with regard to aspects relevant to the radiological safety, are:

- The Ministry of Environment and Sustainable Development, which issues the environmental agreement (as a prerequisite for the siting license issued by CNCAN) and the environmental authorization (after CNCAN granting the operation license).
- The Ministry of Public Health, which issues the sanitary approvals, in accordance with the regulations in force.

15.2 Implementation of legislative and regulatory requirements on radiation protection for Nuclear Power Plants

In accordance with the Basic Requirements on Radiological Safety (BRRS), the licensee has the general obligation of taking all the necessary actions to reduce the radiation exposure of the workers to the most reasonable low level. The licensee is also responsible for the assessment and implementation of the measures regarding the radiation protection of occupationally exposed workers, as stipulated in the same regulation (radiological zoning, requirements for controlled areas and monitored areas, classification of occupationally exposed workers, information, training and authorization of workers, radiological monitoring of the workplace, individual monitoring of radiation exposure of the occupationally exposed workers, monitoring of radiation exposure in case of accidental and emergency exposures, recording and reporting of the results of individual monitoring of radiation exposure, investigation and reporting of overexposures and abnormal exposures, general requirements for the medical surveillance, medical conditions and special medical surveillance of the occupationally exposed workers, etc.).

In this respect, the licensee has developed individual company policies, regulations and procedures, based on the national laws and regulations, latest ICRP/IAEA recommendations and operating experience of other nuclear power plants. The implementation of the Radiation Safety Policies and Principles is directed through a comprehensive process developed by the Health Physics Department and is detailed in radiation protection procedures covering all aspects of radiation safety. Furthermore, where necessary and appropriate, Operating and Maintenance procedures include radiation safety aspects.

Radiation Protection provisions are documented and approved by CNCAN, for the following:

- Personnel radiation protection training and qualification;
- Operational radiation protection of occupationally exposed workers;
- Personnel dosimetry;
- Public radiation protection;
- Radioactive waste management;
- Management of controlled radiation sources;
- Planning and preparedness for emergency response process.

As stipulated in the BRRS, for each controlled and monitored area, the licensee must nominate in writing at least one responsible person for the radiological safety, who shall be in charge of the application of these Requirements and of the specific regulations in the respective area. The Radiological Safety Responsible must possess a Practice Permit issued by CNCAN, in the field and specialization according with the practices carried on in the controlled/monitored area. In certain cases, CNCAN can request this position to be ensured by a special department, managed by a Radiation Protection Expert (a person having the necessary knowledge and training to carry out the physical, technical or radiochemical tests to evaluate the doses and/or for giving advice in order to ensure an effective protection of individuals and the correct use of protective equipment, and whose capacity to act as expert in this matter is recognized by CNCAN, by issuing a practice permit, in accordance with the specific regulations).

In this respect, the radiation protection function of the Cernavoda NPP organization is assigned to the Health Physics Department, which is led by an Expert in NPP Radiation Protection, licensed by CNCAN, designated as the NPP Radiological Safety Responsible. The NPP Health Physics Department is responsible for:

- implementing Radiation Safety Policies and Principles;
- issuing Radiation Safety Regulations, which define the specific application of these policies and principles;
- establishing, in consultation with the other NPP Departments, the Radiation Protection Process;
- continuously assessing the effectiveness of all aspects of the Radiation Protection Processes and communicating the findings and recommendations to the station management.

The Health Physics Department is directly reporting to Cernavoda NPP Director, who is responsible to assure sufficient resources for the implementation of the radiation protection programs.

The Health Physics Department includes a Radioprotection Technical Services, a Radiation Control Services, the Individual Dosimetry Laboratory and the Environmental Control Laboratory. As requested by CNCAN, the Technical Radioprotection Services Head has been designated as CNCAN Certified Expert in NPP Radiation Protection and the Chief of the Individual Dosimetry Laboratory has been designated as CNCAN Certified Expert in NPP Radiation Protection – limited to individual dosimetry activities.

Also, the CNCAN specific regulations stipulate that the capability of the laboratories which provide dosimetric services and perform radioactivity measurements on effluent samples and environmental samples must be recognized by CNCAN. In this respect, the Individual Dosimetric Laboratory and the Environmental Control Laboratory of the NPP Health Physics Department were designated by CNCAN to be able to perform the respective measurements, according to the Requirements on the Designation of Notified Bodies for the Nuclear Field.

15.2.1 Dose Limits

In Romania, the dose limits for the population, as stipulated in art. 56 of BRRS are:

- 1 mSv per year of effective dose; in special situations, CNCAN may authorize an annual superior limit of up to 5 mSv in a year, provided that the average of the effective dose on a period of 5 consecutive years does not exceed 1 mSv per year;
- 15 mSv per year, equivalent dose for the lens of the eye;
- 50 mSv per year, equivalent dose for the skin.

For the occupationally exposed workers, art. 53 of BRRS establishes the following dose limits:

- 20 mSv per year, effective dose;
- 20 mSv per year, equivalent dose for the lens of the eye ;
- 500 mSv per year, equivalent dose for skin;
- 500 mSv per year, equivalent dose for the extremity of hands and legs.

In order to maintain doses as low as reasonably achievable, Cernavoda NPP has established an administrative limit for the occupationally exposed workers of 14 mSv/ year effective dose.

15.2.2 Occupational Exposure

As stipulated in art. 103 – 106 of BRRS, the licensee shall ensure the systematic individual monitoring of all category A workers (occupationally exposed workers for whom there is a significant probability of receiving an effective annual dose or an equivalent annual dose higher than three tenths of the legal limit of the respective dose); in those cases where these workers are likely to receive significant internal contamination, individual monitoring shall include also internal contamination monitoring. For the category B workers (those occupationally exposed workers not included in category A), the individual monitoring shall be at least sufficient to demonstrate that such workers are correctly assigned to this category.

In order to fulfil these requirements, Cernavoda NPP has established and implemented an Individual Dosimetry Program, which is intended to provide a proper evaluation, measurement and recording of radiation doses received at Cernavoda NPP by occupationally exposed workers (both Cernavoda NPP employees and external workers - contractors). Radiation workers at Cernavoda NPP are classified both as category A and B occupationally exposed workers. All radiation types which are significant from the dosimetry point of view are monitored with appropriate frequency and monitoring devices for accurate determination of external and internal doses likely to be received.

The routine individual dosimetry program consists of:

- Monthly evaluation of individual penetrating dose equivalent, $H_{p(10)}$, due to gamma radiation and individual superficial dose equivalent, $H_{s(0.07)}$, due to beta & gamma radiations, both measured with individual TLD’s;
- Estimation of committed effective dose, E_{50}, due to tritiated heavy water intakes, by LSC beta-spectrometry analyses of urine samples, provided with a frequency depending on the tritium concentration on the last sample (28, 7 or 1 day);
- Estimation of committed effective dose, E_{50}, due to gamma-emitters intakes, by in vivo measurements with Whole Body Counter; the monitoring frequency is for each new person at the initialization in the DOSERECORDS database and monthly or quarterly (for Fuel Handling personnel), annually (for operation, maintenance and health physics departments) and once in 3 years (for the rest of the NPP personnel).

Special individual monitoring is provided in the following situations:

- Working in neutron fields: the external doses due to neutrons, $H_{p(10)}$ is assessed by integrating in time the neutron dose rate measured with portable neutron monitors in the most exposed area of the working place;
- Working in not homogenous radiation fields: the workers must wear several TLDs;
- Working in high, variable, no homogenous radiation fields: the worker must wear an electronic dosimeter with direct reading and acoustic alarms;
- For those activities which entail anticipated exposures to tritium significantly higher than the usual situation, the urine samples must be provided before and after the work; when there are known or suspected significantly high, unanticipated, exposures to tritium, all those persons which might be affected must provide supplementary urine samples for evaluation of the committed effective dose;
- For those activities which entail anticipated intakes of gamma-emitters significantly higher than the usual situation, the whole body monitoring must be performed before and after the work; when there are known or suspected significantly high, not anticipated intakes of gamma-emitters, all those persons which might be affected must perform supplementary whole body monitoring;
- For those activities which entail anticipated beta-gamma dose rates at contact with extremities 10 times higher than those registered at the thorax level, the worker must wear TLDs for extremities.

The management of the estimated doses is done through dedicated software and database (DOSERECORDS), which also issue routine reports. The dose registrations are reported as follows:

- Daily and monthly reports regarding the systematic individual monitoring;
- Quarterly reports to the NPP management;
- Half-yearly reports to CNCAN;
- Annually and at the end of working for NPP to the employee (own and outside workers);
- At request, to external organizations.

The dosimetric services are provided for the NPP by the Individual Dosimetry Laboratory. Since 2001 this laboratory participates on international intercomparison exercises, as a member of PROCORAD Association from France, for H-3, C-14 and gamma-spectrometry analyses in urine. The results for each category of analyses met the acceptance criteria since 2001 to 2018. The laboratory is being designated as "reference laboratory" for C-14 in urine in 2001, 2004, 2006 2007, 2008, 2009, 2010, 2012, 2013 and 2018 and for H-3 in urine in 2004, 2006 and 2007. Also the laboratory regularly participates in COG intercomparison exercises for external dosimetry since 2007 to 2018 meeting acceptance criteria.

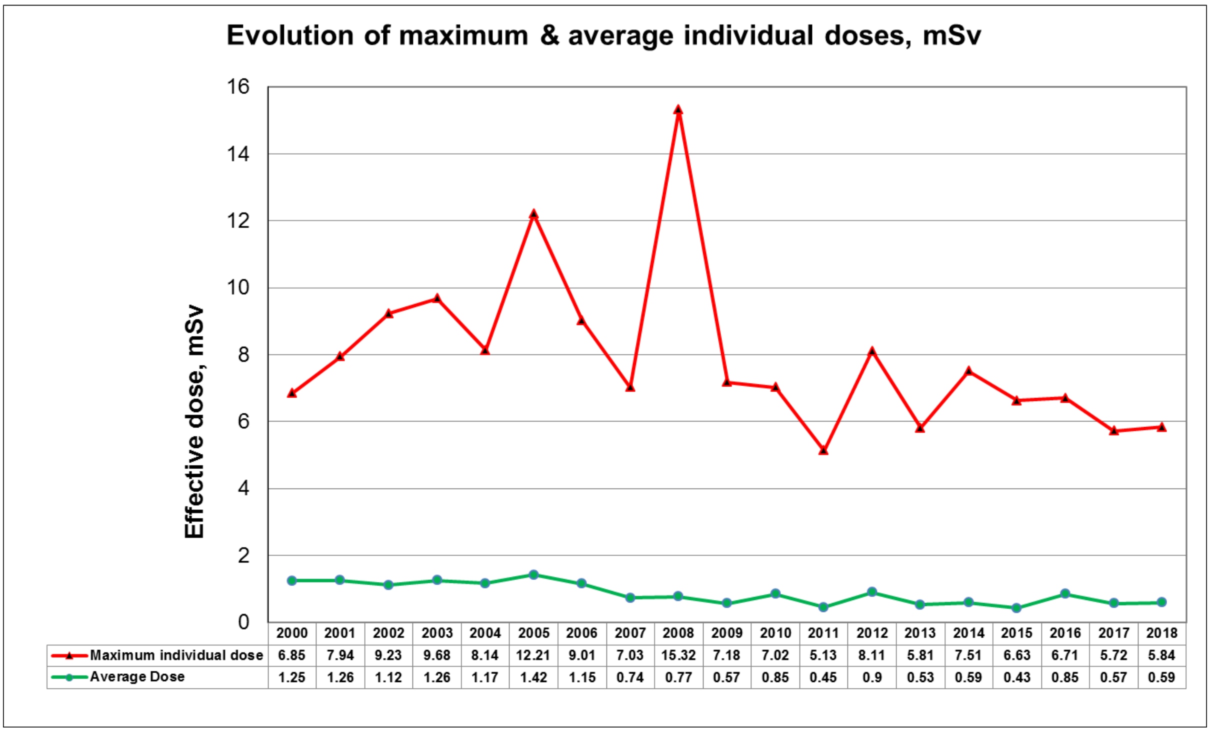


Fig. 15.1

The average effective dose for a Cernavoda NPP worker in 2018 was 0.594 mSv with a maximum of 5.84 mSv. The evolution of mean and maximum individual effective doses for Cernavoda NPP workers is shown in Fig. 15.1.

The Individual Dosimetry Program is supplemented by a Monitoring Program of Working Places, established and implemented in order to evaluate the radiological conditions in the NPP controlled areas, assuring by this a decisional support in those matters regarding the warning, access control, approval of works and individual monitoring, as well as a valuable back-up for estimation of the individual doses. The routine monitoring program includes:

- Measurements of gamma and neutron dose rates, tritium in air concentrations, aerosols (alpha, beta, gamma), iodine in air, (alpha, beta, gamma) surface contamination levels; the scope and frequency of measurements inside the NPP are established taking into consideration the anticipated hazards and are modified, as the case may be, based on the accumulated experience.
- Contamination monitoring of the personnel: the contamination of all employees walking from zone 1 (a controlled area containing systems and equipment which can be significant sources of contamination and/or dose rates higher than 10 μSv/h) to zone 2 (a controlled area without radioactive systems and sources, excepting those approved sources, usually without contamination, but which can be contaminated and where the dose rates are less than 10 μSv/h) and zone 3 (a controlled area without radioactive sources, excepting those approved sources, with very low probability of contamination

spread from adjacent areas and where the dose rates are less than 0.5 μSv/h) is monitored. From zone 1 to zone 2 it is necessary to monitor the beta-gamma contamination of hands and foot, from zone 2 to zone 3, the beta-gamma contamination of whole body.

- Contamination monitoring of materials and equipment: all the materials and equipment moving from zone 1 to zone 2 are monitored for beta-gamma contamination and, for radioactive materials (solid waste and transport equipment), the gamma dose rate.
- Surveillance of radiation fields for routine activities: these checks are specified in the Radiation Work Permit and they must be performed by the employees before starting the work.
- In the last 2 years, alpha emitting radionuclides monitoring and control in Cernavoda NPP have been significantly improved by introducing best industry practices. Plant areas and systems have been characterized and classified according to the abundance of loose alpha contamination relative to the presence of loose beta-gamma contamination. Alpha monitoring equipment is available providing the capability for workplace and personnel monitoring to determine the alpha hazard and protect workers.

The communication and registration of the results of the monitoring program of NPP working places are made through warning panels placed in field, monitoring sheets and Hazard Info database electronic system.

During 2014 the implementation of Radiation Monitoring System (RMS) at Cernavoda U1 was started. This project was finalized in 2018.

The purpose of this improvement is to connect the on-line radiation monitoring equipment to a computerized interface system that allows remote monitoring, limited remote control capability and maintaining integrated short and long-term database.

Radiation Monitoring System integrates all fixed radiation monitoring equipment, uses a local area network (LAN) and dedicated components and software to control the field equipment, store and display the measured or processed data, trends. RMS interfaces with the following systems: Fixed Gamma Area Monitoring, Fixed Contamination Monitoring, Portable Radiation Monitors, Fixed Tritium in Air Monitoring, Liquid Effluent Monitor, Gaseous Effluent Monitor and Post Accident Air Sampling and Monitoring.

Thus the collective dose of the operating personnel decreased (by avoiding the entrance in high radiation hazard areas) and a better radiation hazard control was improved for the normal operation of the plant (due to real time radiation hazard information).

Further implementation of radiation protection systems modification leading to personnel and public exposure optimization represents a top priority for the plant management and health physics department staff.

Since Unit#2 fuel load and first criticality in 2007 efforts have been made for the integration of both units radiation protection programs and systems related to personnel dosimetric surveillance (i.e. Personal Alarm Dosimeters databases and computers serving Liquid Scintillator Counters for tritium analysis in urine samples, in Unit 1 and Unit 2, were connected with the unique DOSERECORDS system). Also DOSERECORDS (a package consisting of a database and a number of specific programs) was adapted to support and work with dose information from both units. This unique dosimetric surveillance system ensures that individual dose limits are not exceeded no matter an employee works in Unit#1, Unit#2 or both units.

Since the dose is a measure of the potential detriment on the health of an individual following the exposure of the human body to ionizing radiation, as a conservative decision from the radiation workers protection point of view, at the beginning of 2008 it has been decided to lower the recording levels for deep individual dose equivalent Hp(10), shallow individual dose equivalent Hp(0.07) and effective internal dose E50, from 0.17 mSv per month to 0.1 mSv per month.

15.2.3. Public Exposure

As requested in the regulations in force, the release into the environment of liquid or gaseous radioactive effluents can be made only in compliance with the DELs approved by CNCAN.
Also, the Radioprotection Regulation of Cernavoda NPP stipulates that the radioactive emissions levels shall be maintained below the DELs approved by CNCAN, in order to optimise the public radiation protection.

According to the CNCAN monitoring requirements, the NPP shall ensure the adequate monitoring of all radioactive discharges, at the source as well as in the receiving media, in all operational phases (from preoperational to decommissioning) and conditions (normal operation and radiation emergency situations). In this respect, the radioactive effluents of Cernavoda NPP are monitored in the discharge points, through the Gaseous and Liquid Radioactive Emissions Monitoring Program and in the environment, through the Environmental Radioactivity Program.

15.2.3.1 Radioactive Releases

According to the Gaseous and Liquid Radioactive Emissions Monitoring Program, the radioactivity emissions are continuously monitored by the Gaseous Effluent Monitoring System (GEM) and Liquid Effluent Monitoring System (LEM), installed in both units and continuously sampled for further periodic laboratory analyses.

The potentially contaminated air inside NPP comes from:
- Central Contaminated Exhaust System: the air from this system is filtered through a High Efficiency Particulate Air (HEPA) filter;
- Reactor Building Exhaust System: the air from the Reactor Building is passed through a pre-filter, a HEPA filter, an activated charcoal filter (to retain radioiodine) and a final HEPA filter;
- Spent Fuel Bay Exhaust System: filtration of this air is similar to that of the Reactor Building;
- D_2O Enrichment Tower Exhaust System: this air is not filtered, because it contains only tritium
- In those areas of the station where heavy water systems exist, the Closed Cycle Vapour Recovery System recovers much of the tritium.

After filtering, all potentially contaminated exhaust air is routed to the exhaust stack, which disperses it to the environment. Representative samples of the air flow in the stack are continuously extracted and routed to the GEM, by an isokinetic sampling system.
The GEM is designed to:
- monitor the total activities of particulate, radioiodine and noble gases;

- alarm (locally and in MCR) when predefined release setpoints are exceeded;
- collect samples on adequate sampling media, for further laboratory analyses to determine the particulate, radioiodine, total tritium and total C-14 content of gaseous effluents.

The particulate filters are changed and measured daily, by gamma-spectrometry and gross-beta analyses. The charcoal filters for radioiodine are changed and measured daily, by gamma-spectrometry analyses. In case of High Activity Release Alarm provided by GEM, the filters are immediately changed and measured in the Chemical Laboratory. In routine situations, the filters are measured in the Individual Dosimetry Laboratory, which also analyses the H-3 and C-14 concentration in effluent samples. Tritiated water vapours are trapped in molecular sieve at Unit 1 and both forms of tritium, tritiated water and gas tritium, are trapped in demi water at Unit 2. After extraction from sampling media, tritium content is measured by LSC, daily in both Units. Both inorganic and organic forms of C-14 are extracted from NaOH solution and measured by LSC, daily in both Units. These laboratory analyses results represent the data of the NPP gaseous discharges that are officially reported to the management and to the relevant authorities.

Radioactive liquid wastes resulted from the operation of Cernavoda NPP are collected in five liquid effluent hold-up tanks (approx. $50m^3$ each) at each Unit. Before the discharge, the content of a tank is recirculated in order to assure a good homogeneity and a representative sample is taken, which will be analyzed in the Chemical Laboratory for gross-gamma activity and tritium concentration. Based on these laboratory analyses, the Shift Supervisor will approve the discharge if the radioactive level is below the established limits. In order to limit the radioactive concentration, during the discharge it must be assured a minimum dilution factor. If radioactive aqueous liquid waste doesn’t meet the requirements to be discharged as liquid effluents, it must be decontaminated or temporarily stored.

Each liquid discharge from the NPP is monitored by the LEM, which is designed to:

- continuously monitor the gross-gamma activity discharged;
- collect a representative integrated sample, for further laboratory analyses;
- automatically stop the discharge and provide an alarm (locally and in MCR) if a preset count rate set point is exceeded, or if any malfunction occurs on LEM.

The samples collected by LEM are measured in the Individual Dosimetry Laboratory, by gamma-spectrometry analyses, LSC for H-3 concentration, LSC on weekly composite samples for C-14 concentration, gross-beta analyses on weekly composite samples. These laboratory analyses results represent the data of the NPP liquid discharges that are officially reported to the management and to the relevant authorities.

Supplementary, the Individual Dosimetry Laboratory measures, weekly, an integrated sample (continuously collected) from CCW, by gamma-spectrometry and gross-beta analyses and LSC for H-3 determination. These samples are analyzed only for verification purposes.

As requested by the CNCAN Requirements for the Monitoring of Radioactive Emissions from Nuclear and Radiological Installations, the capability of the laboratory performing the radioactivity measurements on effluents samples must be recognized by CNCAN. In this respect, the Individual Dosimetry Laboratory which provides the official data on radioactive discharges, beside dosimetric services for Cernavoda NPP, was designated by CNCAN as a “notified body” not only for dosimetric services, but also for radioactive effluents monitoring.

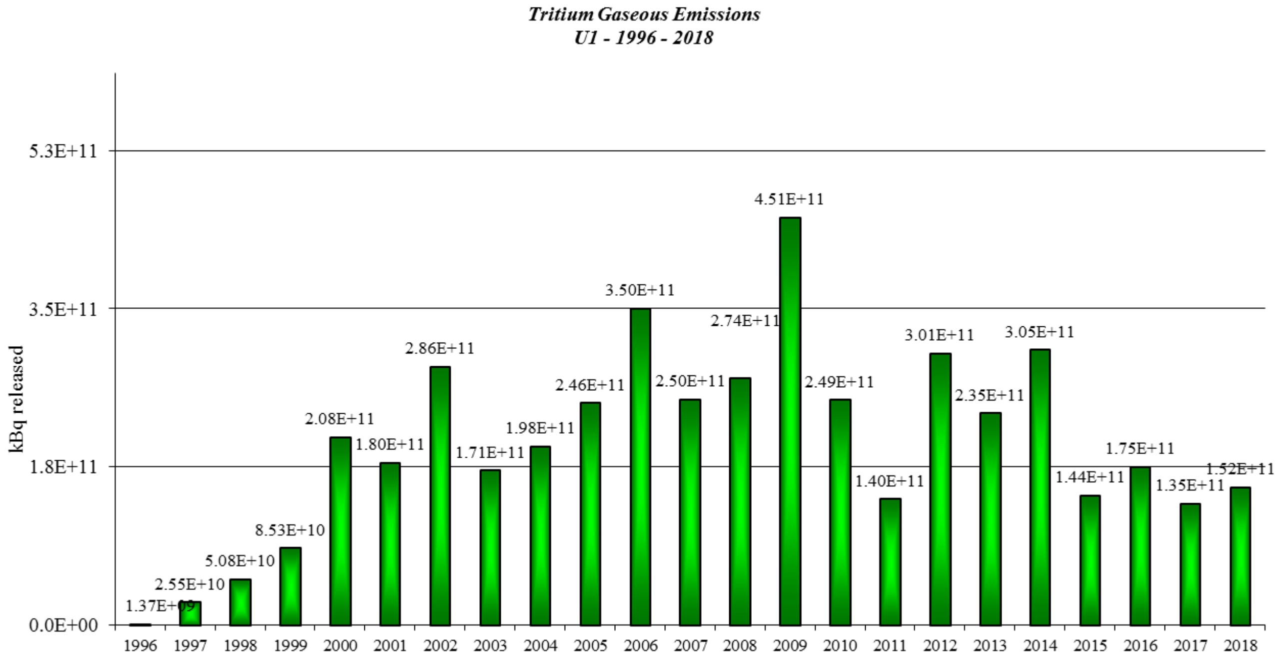
A summary of the gaseous and liquid emissions data are reported quarterly to CNCAN, the fourth report representing the annual one. The results of the Gaseous and Liquid Radioactive Emissions Monitoring Program are also included in the annual report on environmental monitoring program. Also, any gaseous emission exceeding the limits is immediately notified to CNCAN.

Since the beginning of the commercial operation of Cernavoda NPP, all the radioactive emissions were far below the Derived Emission Limits. Fig. 15.2 a, b and c show the evolution of gaseous emissions from Cernavoda NPP Unit 1 and Fig 15.2.d, e and f for Unit 2. Fig. 15.3 a shows the evolution of tritium liquid emissions from Cernavoda NPP Unit 1 and Fig 15.3 b from Unit 2.

The %ADEL (% Annual Derived Emissions Limits) graphs start with 2008, the time when new Derived Emissions Limits have been implemented in accordance with CNCAN requirements. As shown in trends of tritium levels in airborne emissions, for the same period of operation (8 years) Unit 2 levels are consistently lower than those observed at Unit 1. This behaviour can be explained by considering the benefits that come from:

- using a dedicated unit for drying the R/B inlet flow air (this lead to an increased efficiency of Water Vapour Recovery System);
- continuous improvement of on-line monitoring by using a state-of-the-art Tritium in Air Monitoring System;

The effective doses for Critical group members have been calculated using new DEL's model and parameters values.


Tritium Gaseous Emissions
U1 - 1996 - 2018
kBq released
0.0E+00
1.8E+11
3.5E+11
5.3E+11
1.37E+09
2.55E+10
5.08E+10
8.53E+10
2.08E+11
1.80E+11
2.86E+11
1.71E+11
1.98E+11
2.46E+11
3.50E+11
2.50E+11
2.74E+11
4.51E+11
2.49E+11
1.40E+11
3.01E+11
2.35E+11
3.05E+11
1.44E+11
1.75E+11
1.35E+11
1.52E+11
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

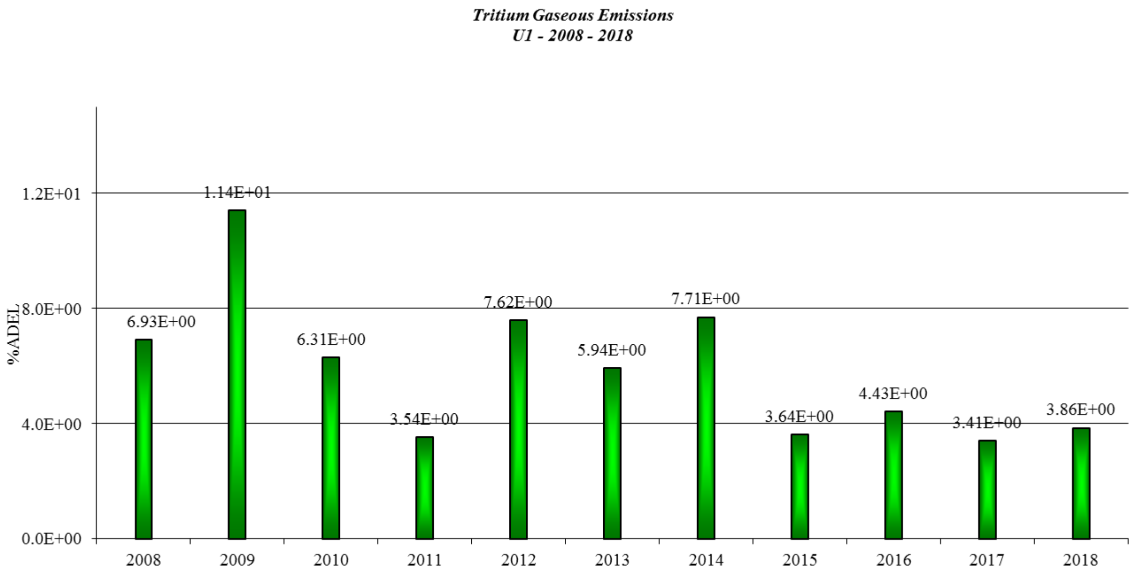
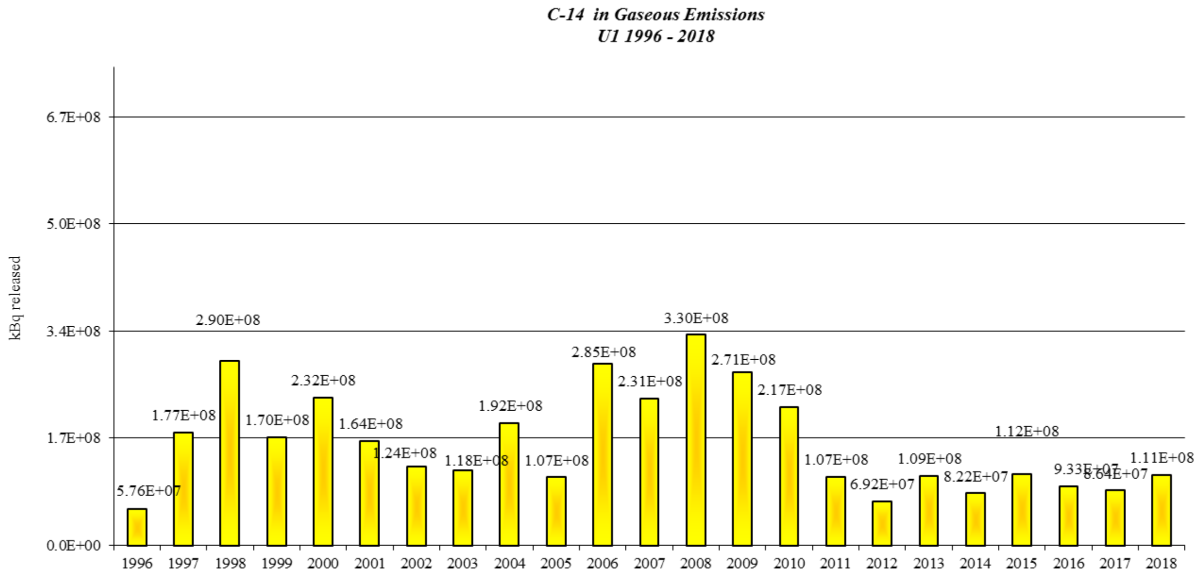

Tritium Gaseous Emissions
U1 - 2008 - 2018
%ADEL
0.0E+00
4.0E+00
8.0E+00
1.2E+01
6.93E+00
1.14E+01
6.31E+00
3.54E+00
7.62E+00
5.94E+00
7.71E+00
3.64E+00
4.43E+00
3.41E+00
3.86E+00
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Fig. 15.2.a


C-14 in Gaseous Emissions
U1 1996 - 2018
kBq released
6.7E+08
5.0E+08
3.4E+08
1.7E+08
0.0E+00
5.76E+07
1.77E+08
2.90E+08
1.70E+08
2.32E+08
1.64E+08
1.24E+08
1.18E+08
1.92E+08
1.07E+08
2.85E+08
2.31E+08
3.30E+08
2.71E+08
2.17E+08
1.07E+08
6.92E+07
1.09E+08
8.22E+07
1.12E+08
9.33E+07
8.64E+07
1.11E+08
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

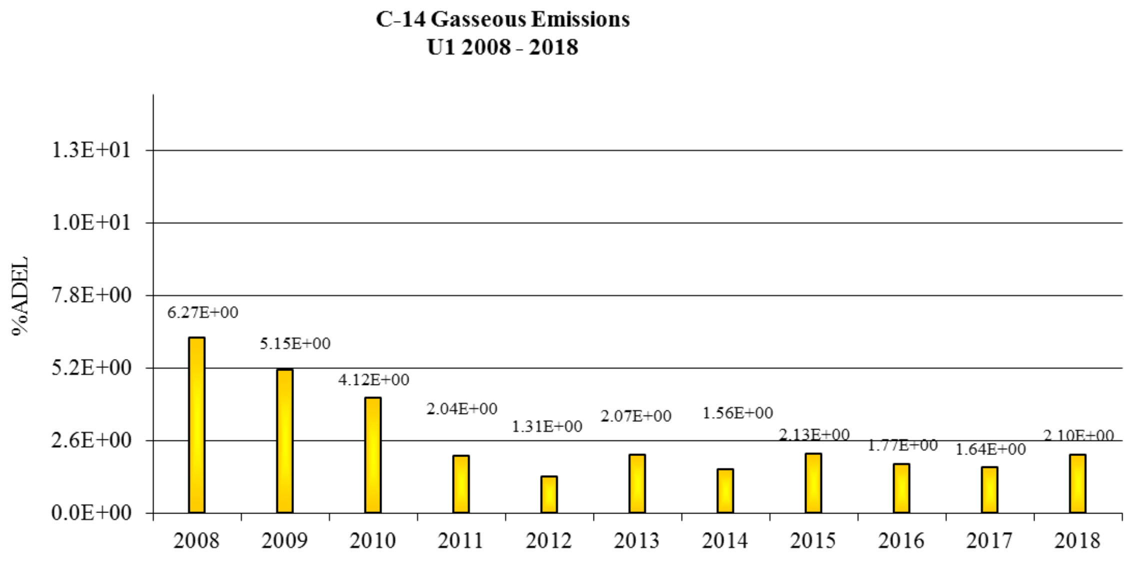
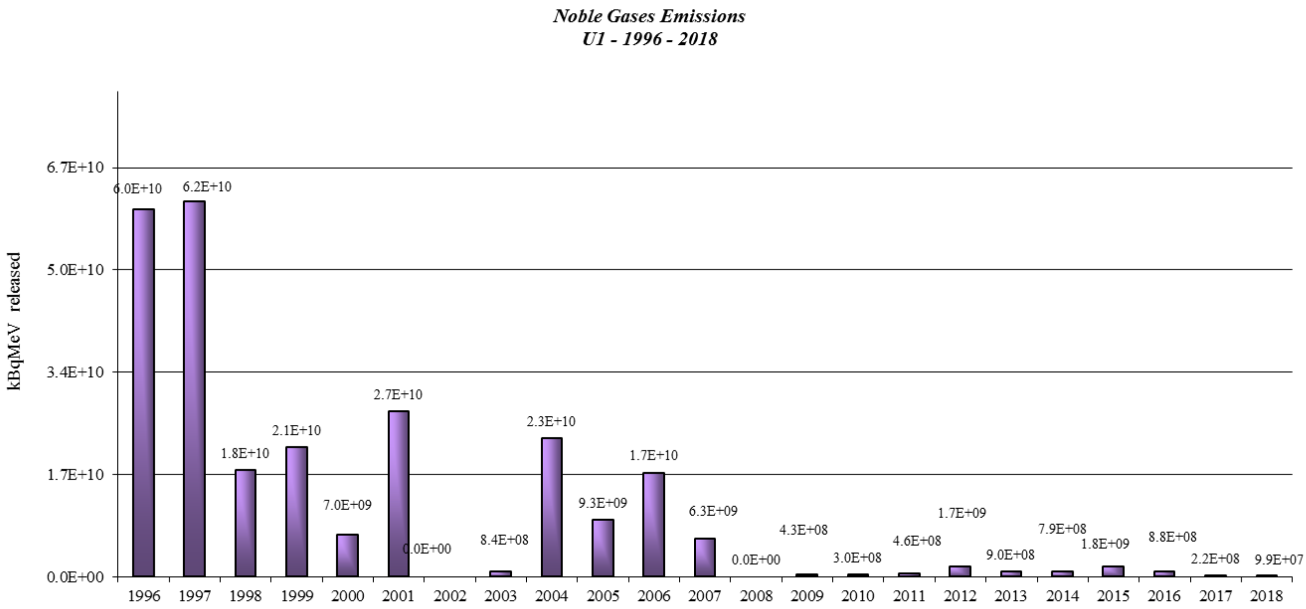

C-14 Gasseous Emissions
U1 2008 - 2018
%ADEL
1.3E+01
1.0E+01
7.8E+00
5.2E+00
2.6E+00
0.0E+00
6.27E+00
5.15E+00
4.12E+00
2.04E+00
1.31E+00
2.07E+00
1.56E+00
2.13E+00
1.77E+00
1.64E+00
2.10E+00
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Fig. 15.2.b


Noble Gases Emissions
U1 - 1996 - 2018
kBqMeV released
6.7E+10
5.0E+10
3.4E+10
1.7E+10
0.0E+00
6.0E+10
6.2E+10
1.8E+10
2.1E+10
7.0E+09
2.7E+10
0.0E+00
8.4E+08
2.3E+10
9.3E+09
1.7E+10
6.3E+09
0.0E+00
4.3E+08
3.0E+08
4.6E+08
1.7E+09
9.0E+08
7.9E+08
1.8E+09
8.8E+08
2.2E+08
9.9E+07
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

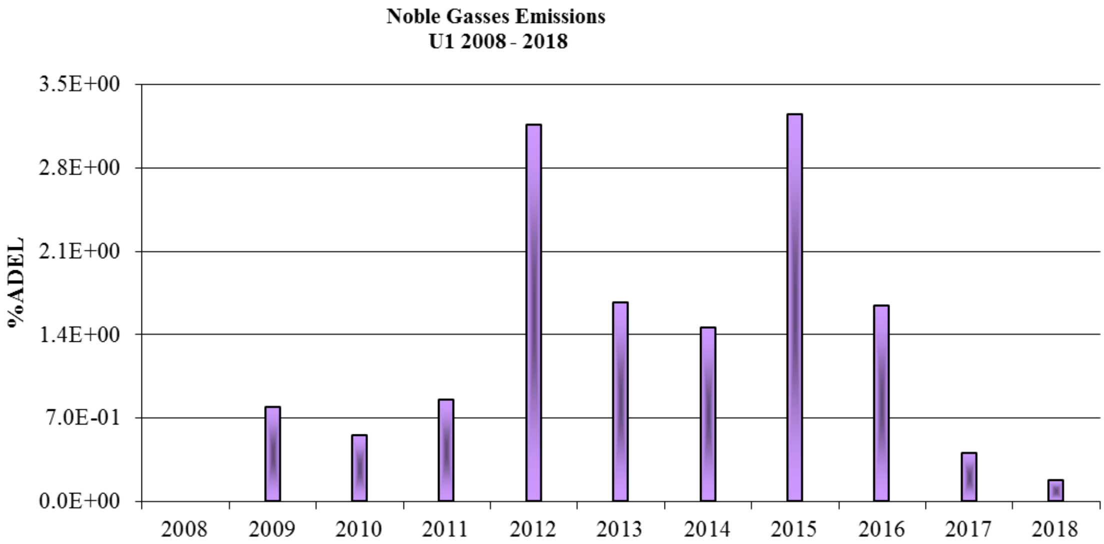
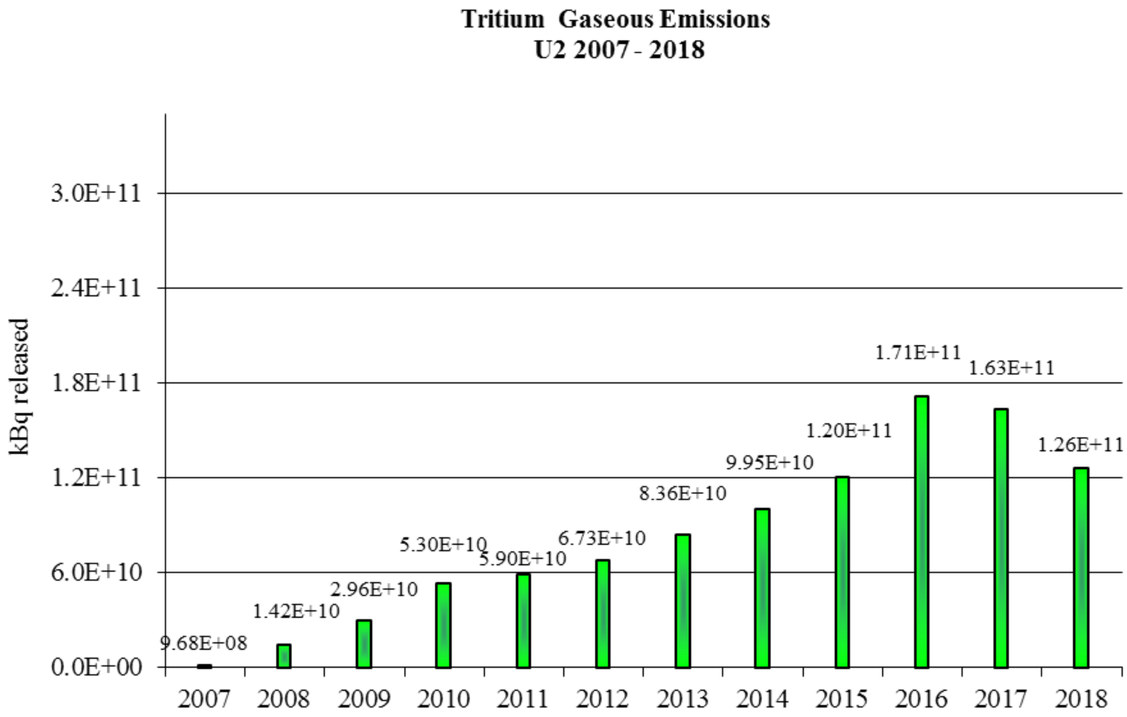

Noble Gasses Emissions
U1 2008 - 2018
%ADEL
3.5E+00
2.8E+00
2.1E+00
1.4E+00
7.0E-01
0.0E+00
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Fig. 15.2.c


Tritium Gaseous Emissions
U2 2007 - 2018
kBq released
3.0E+11
2.4E+11
1.8E+11
1.2E+11
6.0E+10
0.0E+00
9.68E+08
1.42E+10
2.96E+10
5.30E+10
5.90E+10
6.73E+10
8.36E+10
9.95E+10
1.20E+11
1.71E+11
1.63E+11
1.26E+11
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

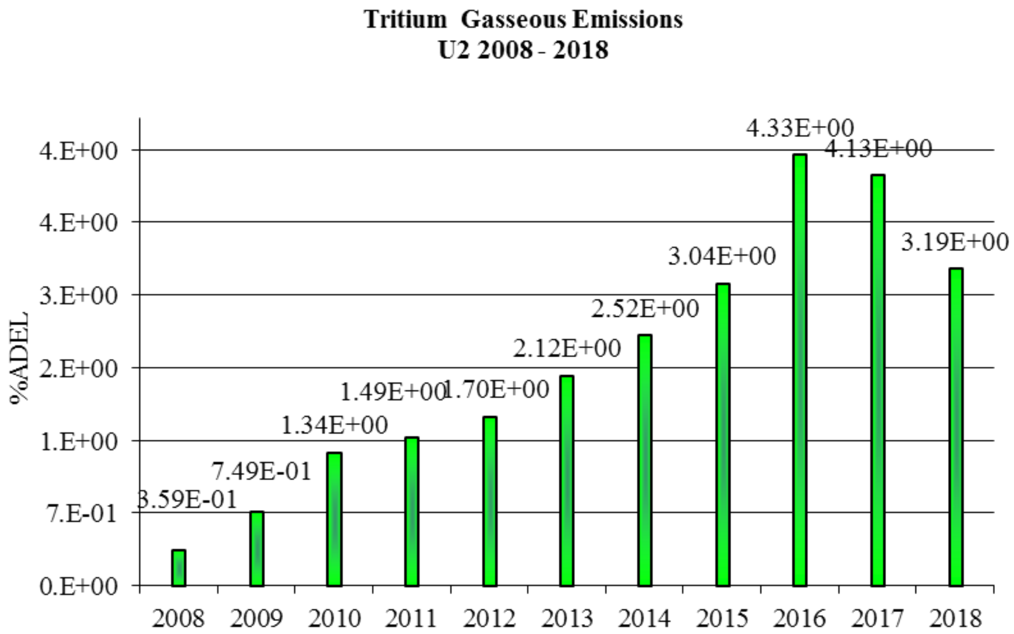
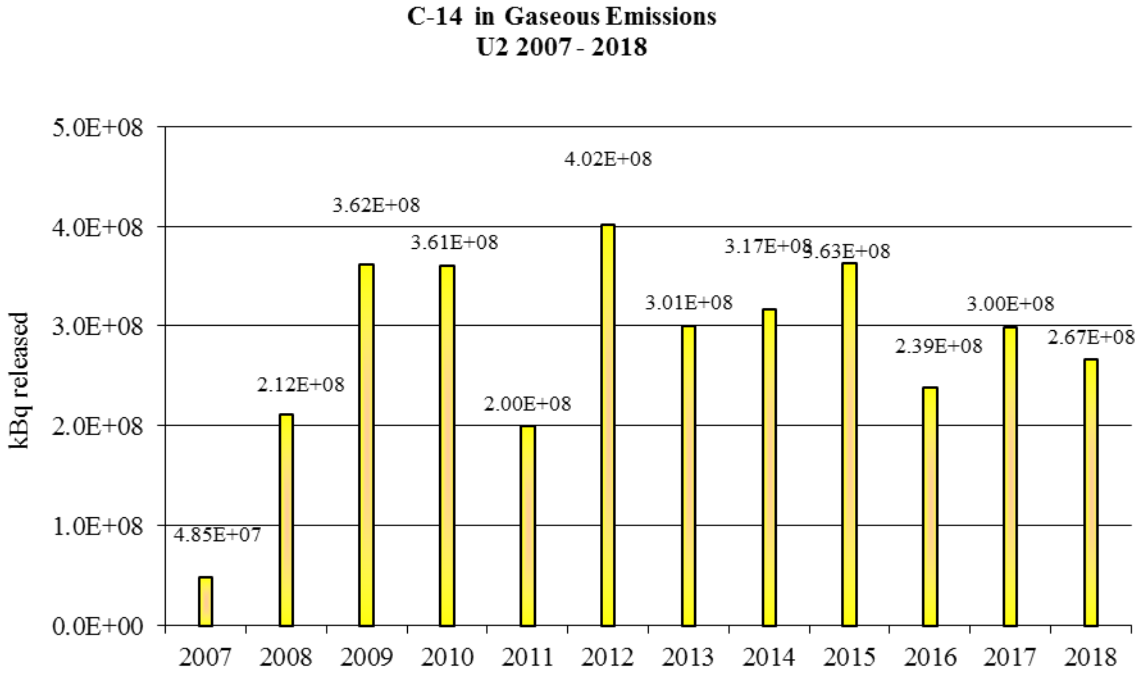

Tritium Gasseous Emissions
U2 2008 - 2018
%ADEL
4.E+00
4.E+00
3.E+00
2.E+00
1.E+00
7.E-01
0.E+00
3.59E-01
7.49E-01
1.34E+00
1.49E+00
1.70E+00
2.12E+00
2.52E+00
3.04E+00
4.33E+00
4.13E+00
3.19E+00
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Fig. 15.2.d


C-14 in Gaseous Emissions
U2 2007 - 2018
kBq released
5.0E+08
4.0E+08
3.0E+08
2.0E+08
1.0E+08
0.0E+00
4.85E+07
2.12E+08
3.62E+08
3.61E+08
2.00E+08
4.02E+08
3.01E+08
3.17E+08
3.63E+08
2.39E+08
3.00E+08
2.67E+08
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

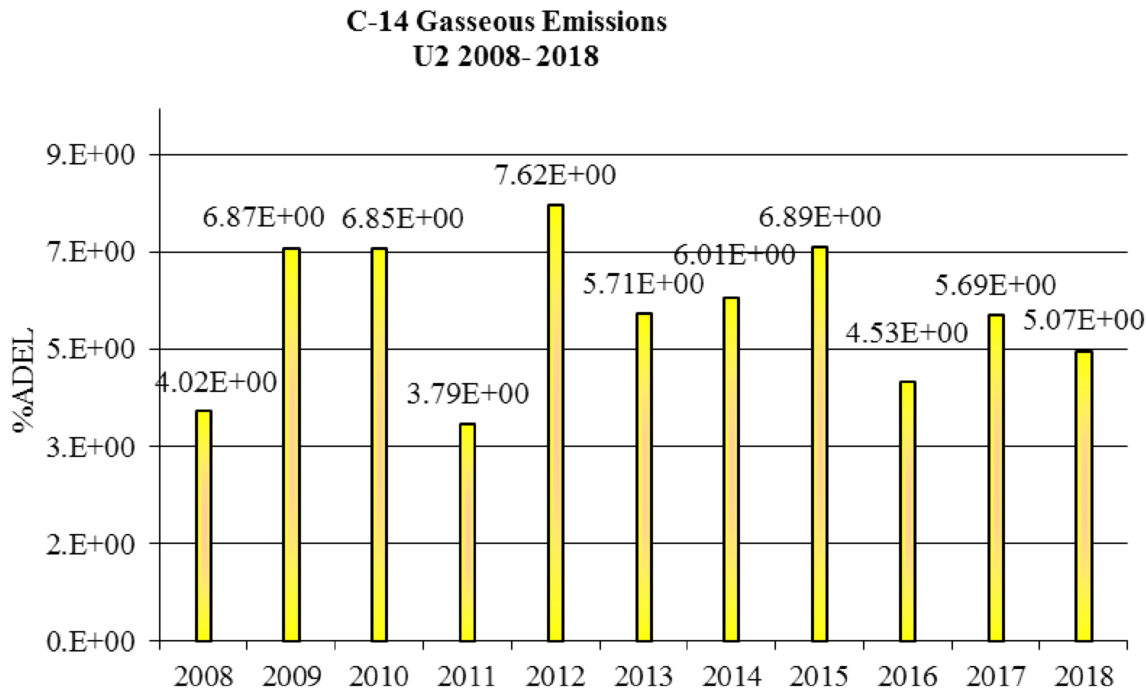
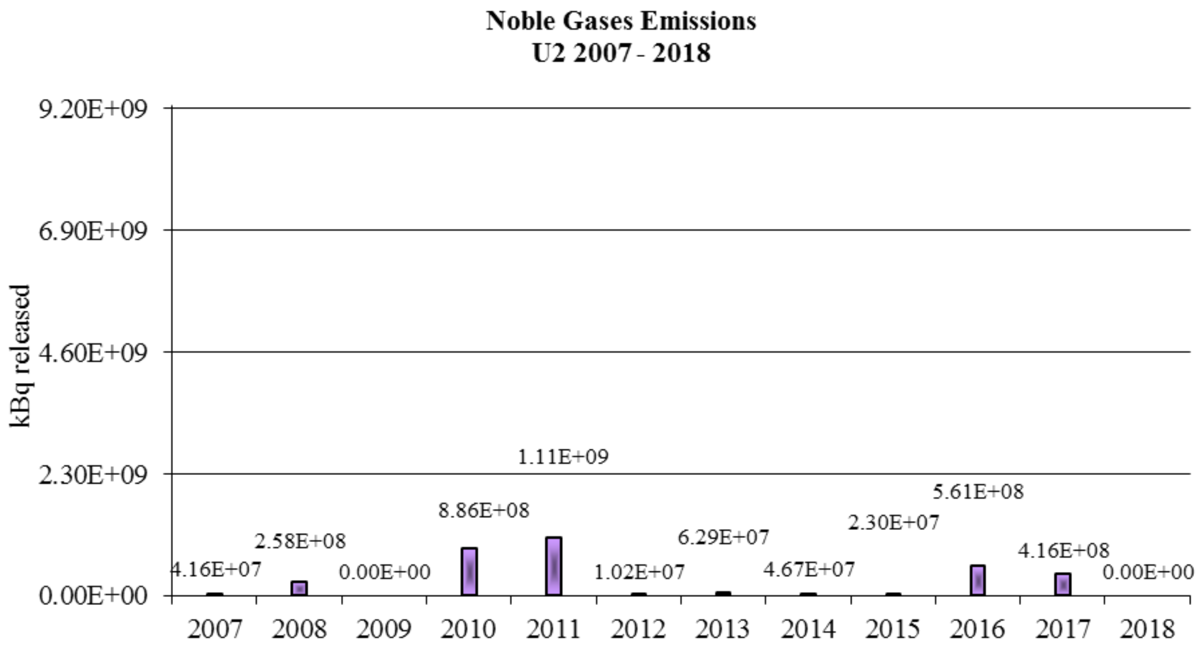

C-14 Gasseous Emissions
U2 2008- 2018
%ADEL
9.E+00
7.E+00
5.E+00
3.E+00
2.E+00
0.E+00
4.02E+00
6.87E+00
6.85E+00
3.79E+00
7.62E+00
5.71E+00
6.01E+00
6.89E+00
4.53E+00
5.69E+00
5.07E+00
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Fig. 15.2.e


Noble Gases Emissions
U2 2007 - 2018
9.20E+09
6.90E+09
4.60E+09
2.30E+09
0.00E+00
kBq released
4.16E+07
2.58E+08
0.00E+00
8.86E+08
1.11E+09
1.02E+07
6.29E+07
4.67E+07
2.30E+07
5.61E+08
4.16E+08
0.00E+00
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

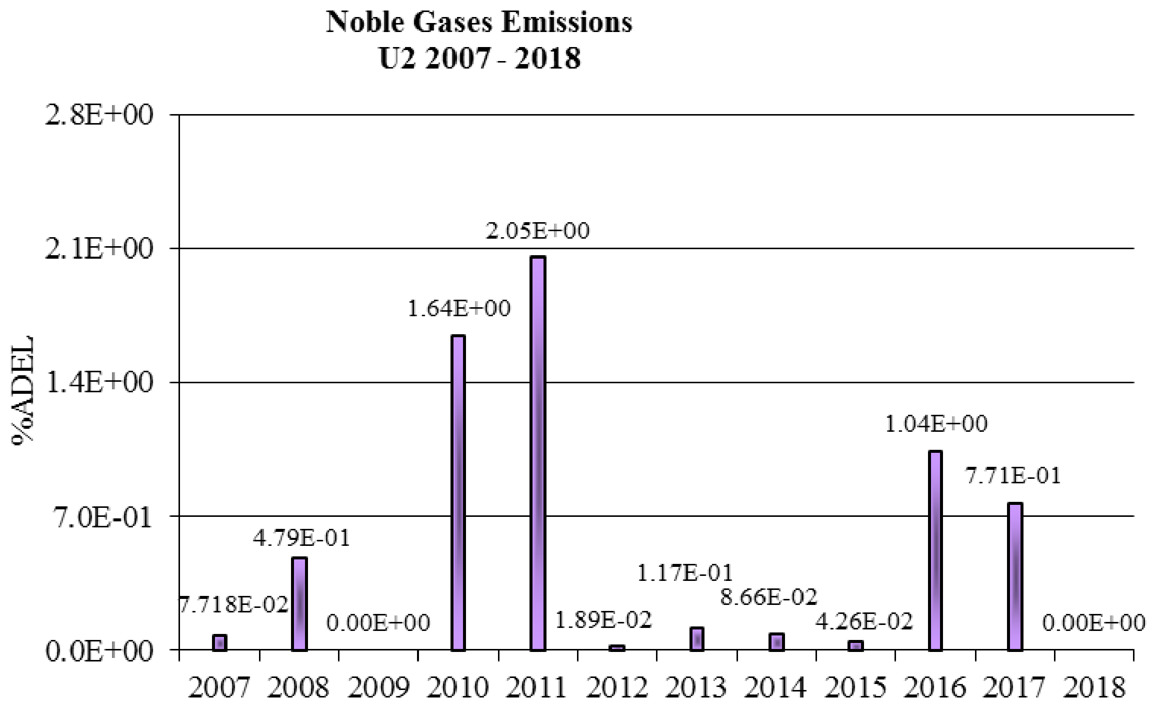
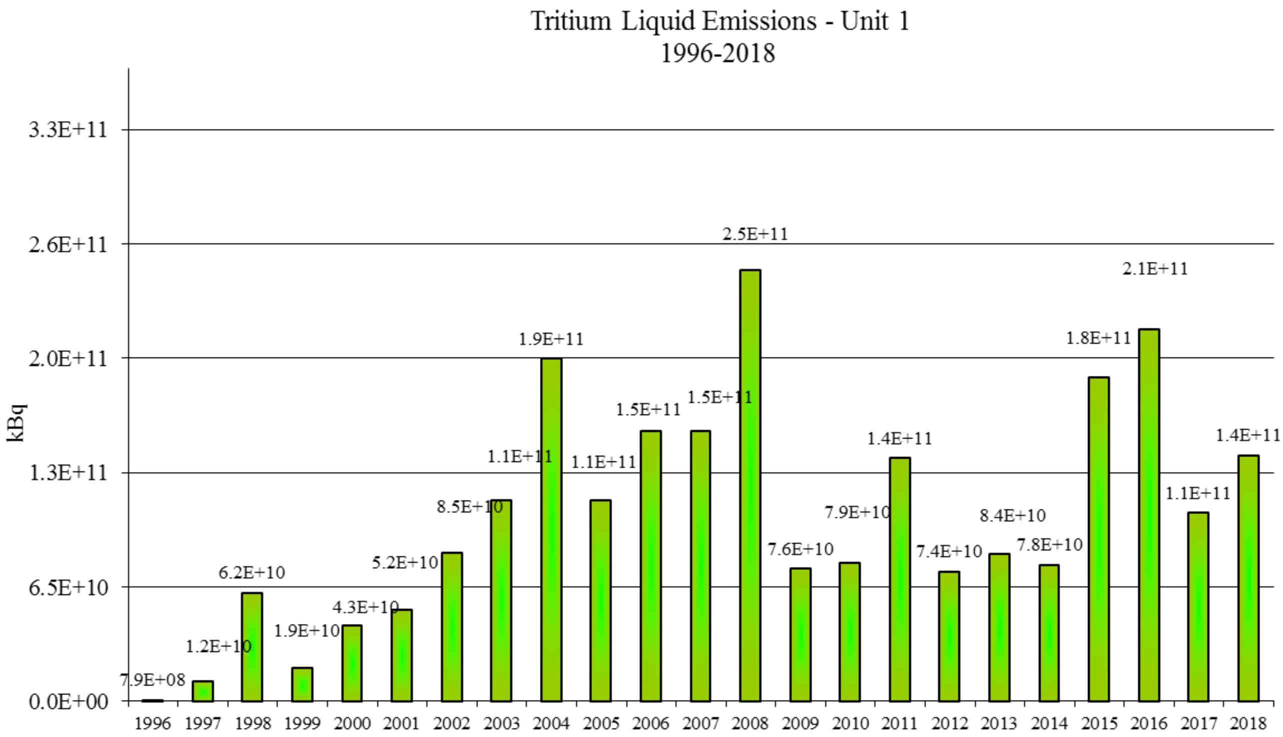

Noble Gases Emissions
U2 2007 - 2018
2.8E+00
2.1E+00
1.4E+00
7.0E-01
0.0E+00
%ADEL
7.718E-02
4.79E-01
0.00E+00
1.64E+00
2.05E+00
1.89E-02
1.17E-01
8.66E-02
4.26E-02
1.04E+00
7.71E-01
0.00E+00
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Fig. 15.2.f


Tritium Liquid Emissions - Unit 1
1996-2018
kBq
3.3E+11
2.6E+11
2.0E+11
1.3E+11
6.5E+10
0.0E+00
7.9E+08
1.2E+10
6.2E+10
1.9E+10
4.3E+10
5.2E+10
8.5E+10
1.1E+11
1.9E+11
1.1E+11
1.5E+11
1.5E+11
2.5E+11
7.6E+10
7.9E+10
1.4E+11
7.4E+10
8.4E+10
7.8E+10
1.8E+11
2.1E+11
1.1E+11
1.4E+11
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

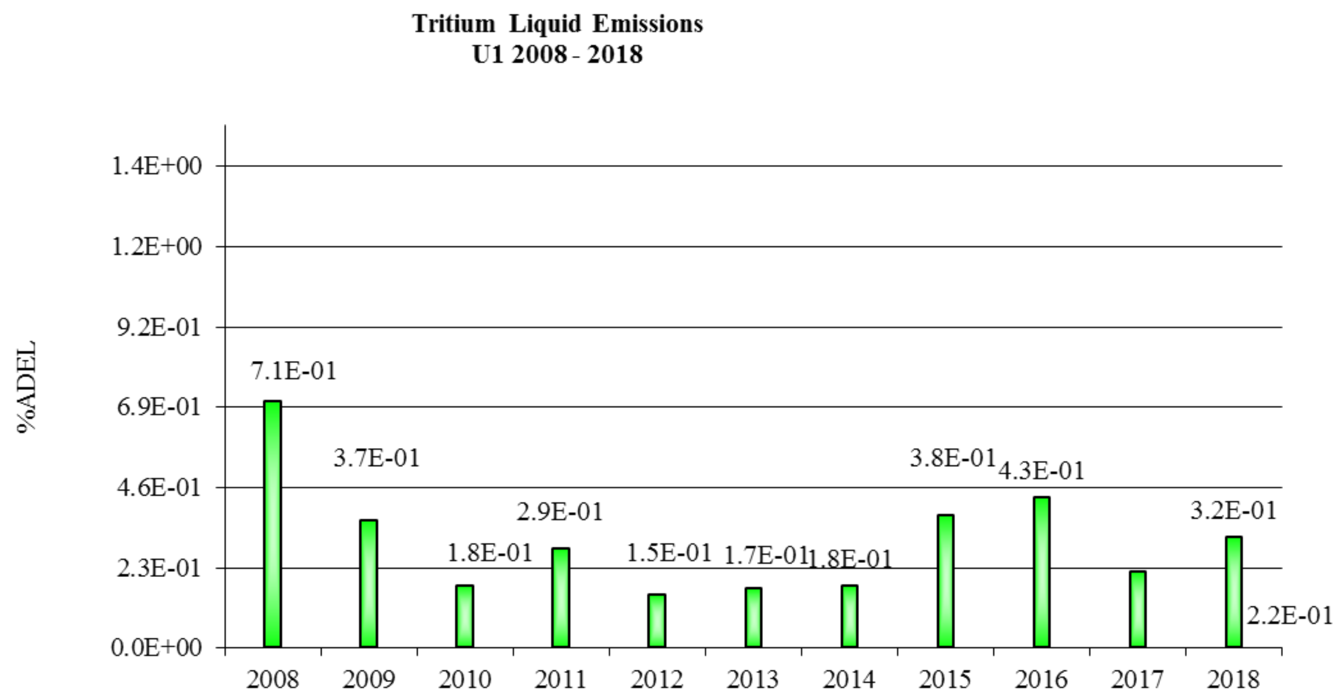
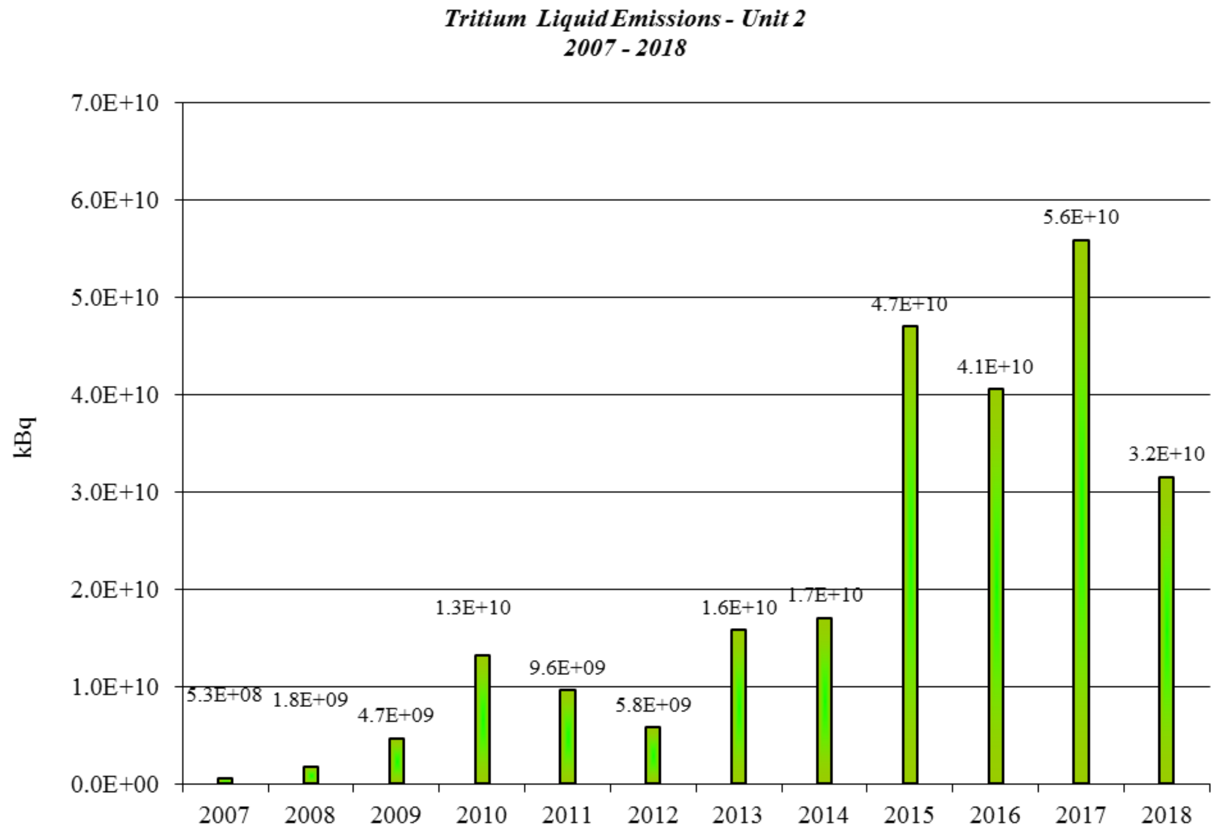

Tritium Liquid Emissions
U1 2008 - 2018
%ADEL
1.4E+00
1.2E+00
9.2E-01
6.9E-01
4.6E-01
2.3E-01
0.0E+00
7.1E-01
3.7E-01
1.8E-01
2.9E-01
1.5E-01
1.7E-01
1.8E-01
3.8E-01
4.3E-01
2.2E-01
3.2E-01
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

Fig. 15.3.a


Tritium Liquid Emissions - Unit 2
2007 - 2018
kBq
7.0E+10
6.0E+10
5.0E+10
4.0E+10
3.0E+10
2.0E+10
1.0E+10
0.0E+00
5.3E+08
1.8E+09
4.7E+09
1.3E+10
9.6E+09
5.8E+09
1.6E+10
1.7E+10
4.7E+10
4.1E+10
5.6E+10
3.2E+10
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

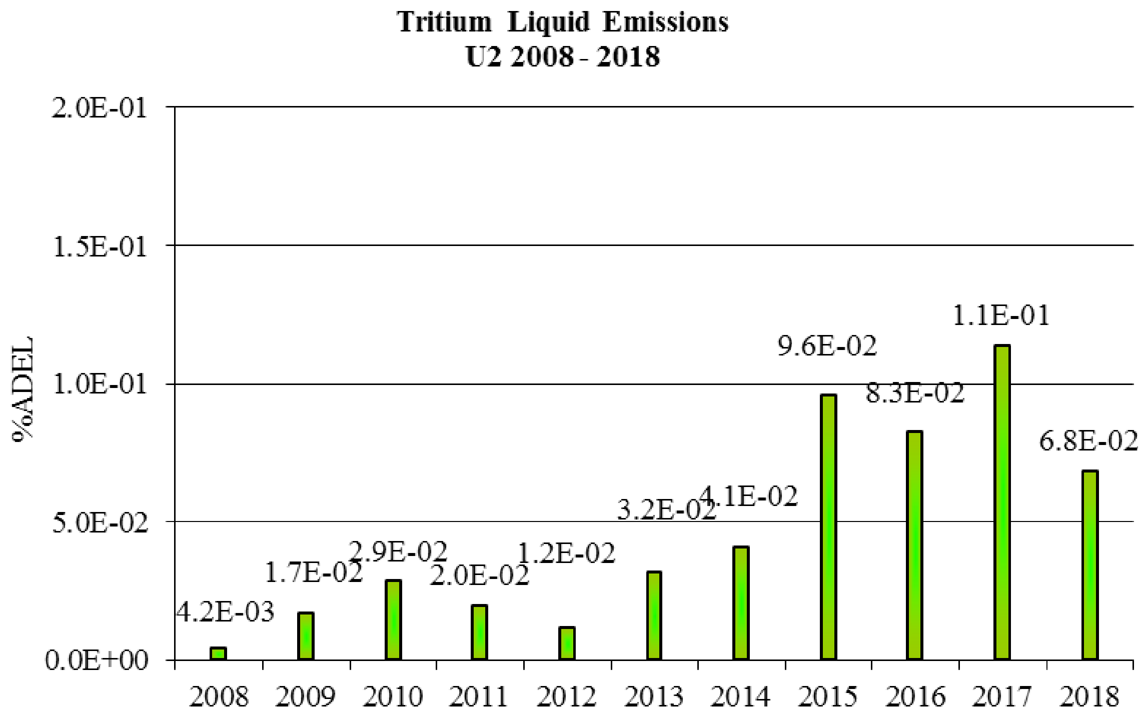

Tritium Liquid Emissions
U2 2008 - 2018
%ADEL
2.0E-01
1.5E-01
1.0E-01
5.0E-02
0.0E+00
4.2E-03
1.7E-02
2.9E-02
2.0E-02
1.2E-02
3.2E-02
4.1E-02
9.6E-02
8.3E-02
1.1E-01
6.8E-02
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

Fig. 15.3.b

15.2.3.2 Environmental Radioactivity Monitoring

The Environmental Radioactivity Monitoring Program of Cernavoda NPP was designed to assure a correct evaluation of the doses for a member of the critical group, by determining the increases of the radioactive levels in the specific environmental media, due to the NPP operation, a correct assessment of the effluents control and monitoring, based on environmental measurements and an estimation of the doses to population in case of significant radioactive releases.

The environmental radioactivity monitoring in Cernavoda area was started in 1984, based on a preoperational monitoring program. The operational program was established and approved in 1995 and implemented in March 1996.

Table 15.1 shows the sample types, sampling frequencies, as well as analytical methods and frequencies established by the environmental monitoring program of the station. All the samples were analyzed in the Environmental Control Laboratory, located at 2 km from Cernavoda NPP Unit 1.

Since 2002, the laboratory is participating annually at international intercomparison exercises, organized by PROCORAD Association from France, for H-3, C-14 and gamma-spectrometry analysis in urine and water. The results obtained for each category of analyses met the acceptance criteria, the laboratory being designated as “reference laboratory” (relative bias < 3% of the reference value for all samples in the exercise) for C-14 analysis in 2004, 2006, 2007, 2011 and 2014 and for H-3 analysis in 2007.

During the period 2008 – 2013, the laboratory participated in proficiency tests with Nuclear Physics Laboratory from UK.

Also, the Environmental Control Laboratory is member of the ALMERA (Analytical Laboratories for the Measurement of Environmental Radioactivity) Network of IAEA since 2005 and is participating annually since 2006 at the proficiency tests organized between the laboratories of the ALMERA Network to measure the radioactivity in environmental samples (gamma spectrometry; gross alpha/ beta measurements; etc.).

The Environmental Control Laboratory started in 2018 a supplementary program for organically bound tritium (OBT) analysis in fish, grass, wheat and potato samples, after a 5-year experience of participation at international intercomparison exercises for OBT analysis. The international project was proposed in 2012 by the OBT International Group formed by the Chalk River Laboratories (former AECL) from Canada, CEA France, University of Southampton from UK, SNN-Cernavoda NPP from Romania and other interested laboratories from different countries, having the main purpose to validate OBT methods and to elaborate an international standard for OBT analysis.

Table 15.1: Environmental samples type, sampling frequencies, analytical methods and analytical frequencies

Environmental media		Sampling frequency	Analysis Frequency
Airborne particulate		Monthly (Integrated sample)	Monthly
Airborne Radioiodine		Quarterly (Integrated sample)	Quarterly
Airborne Tritium		Monthly (Integrated sample)	Monthly
Ambient gamma (TLD's)		Quarterly (Integrated sample)	Quarterly
Water (surface water from Danube)		Weekly	Monthly (composite sample)
Water (CCW duct)		Weekly (Integrated sample)	Weekly
Water (underground water from infiltration)		Monthly	Monthly
Water (deep underground water)		Monthly	Monthly
Water (potable water)		Monthly	Monthly
Soil		Twice a year	Twice a year
Sediment		Twice a year	Twice a year
Milk		Weekly	Weekly (gamma spectrometry and H-3) Monthly (Gross Beta and C-14 on composite sample)
Deposition		Monthly (Integrated sample)	Monthly
Fish		Twice a year	Twice a year
Meat		Twice a year	Twice a year
Vegetables		Annual	Annual
Leafy vegetables		Twice a year	Twice a year
Fruits		Annual	Annual
Eggs		Annual	Annual
Cereals	wheat	Annual	Annual
	maize	Twice a year	Twice a year
Grass		Monthly (May - October)	Monthly (May - October)

The maps showing the monitoring and environmental sampling points around Cernavoda NPP have been included in the 4th National Report under the Convention on Nuclear Safety.

The environmental radioactivity measurements show the presence of tritium in the majority of environmental samples, the obtained values being comparable with the detection limits.

The distribution of the tritium in air concentration measured for the most relevant sampling points and sample types, in comparison with the past years, is presented in the next figure.

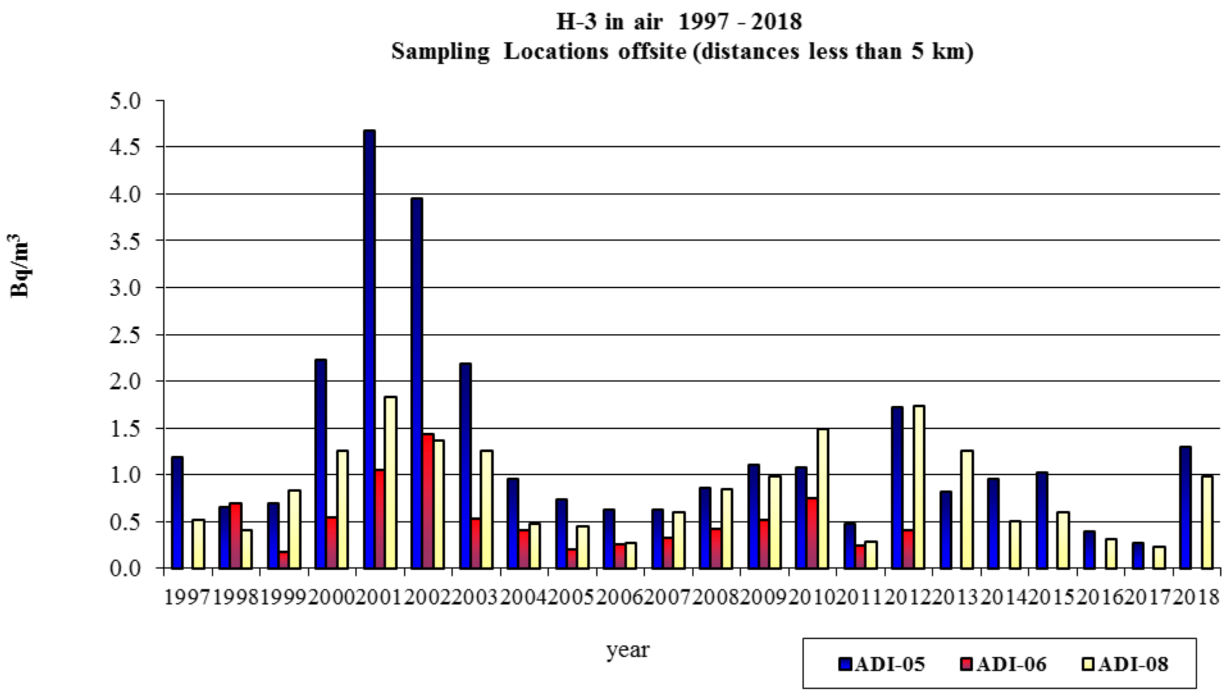


Fig. 15.4

The natural concentration of H-3 in air, determined between 1994 and 1996 as part of the preoperational monitoring program varies between 0.032 Bq/m^3 and 0.186 Bq/m^3.

Fig. 15.4 shows the evolution of H-3 in air for 3 sampling stations located in the close vicinity of the plant (distances less than 5km).

Fig. 15.5 shows the evolution of H-3 in air for 3 sampling stations located at a distance between 5 and 10 km from the station.

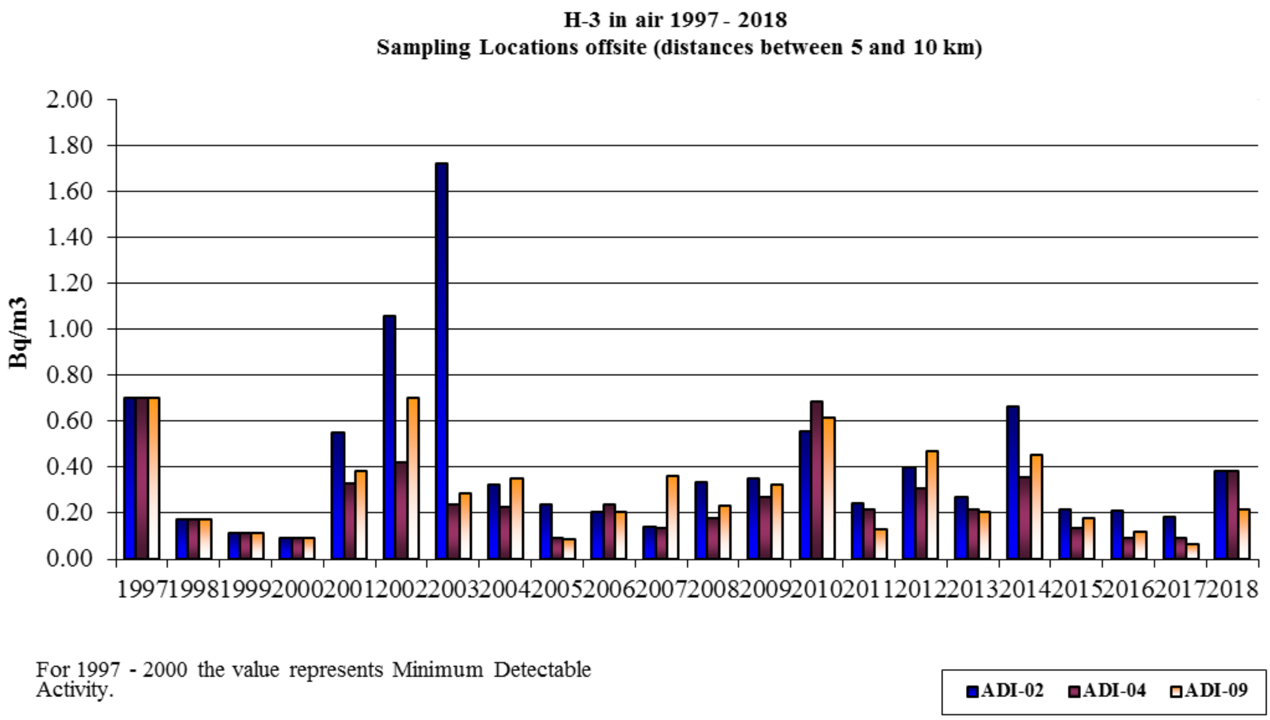


Fig. 15.5

As it will be shown in the next paragraph, these levels of tritium in air concentration will lead to very low values of dose to the public, far below the dose constraints approved by regulatory.

The tritium concentration measured in different environmental samples are used to calculate the doses received by the population. Figure 15.6 shows the evolution of the doses to Cernavoda population due to the presence of tritium into the environment.

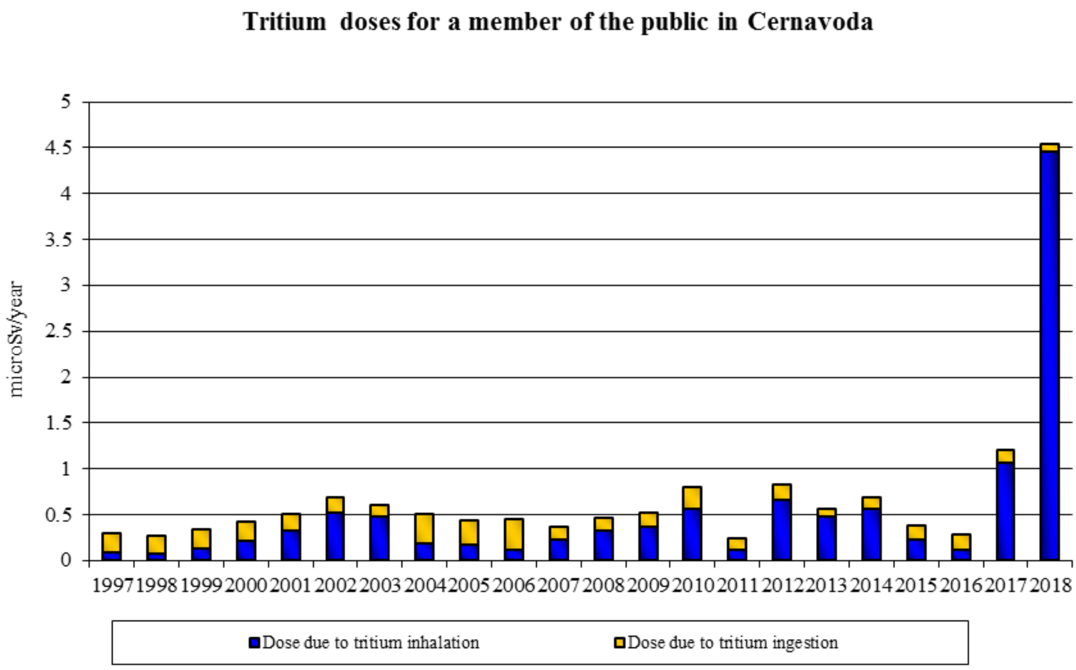


Fig. 15.6

In accordance with the Requirements for the Monitoring of Radioactive Emissions from Nuclear and Radiological Installations, the licensee shall monitor the radioactive effluents at the source, as well as in the receiving media, as requested by the applicable CNCAN regulations and shall present the results of both the associated monitoring programs, in such a form to demonstrate the conformity with the dose constraint established by CNCAN. Furthermore, as stipulated in the above mentioned Requirements, the licensee shall ensure the validity of the dose calculations based on the radioactive emissions using the results of the environmental radioactivity monitoring program.

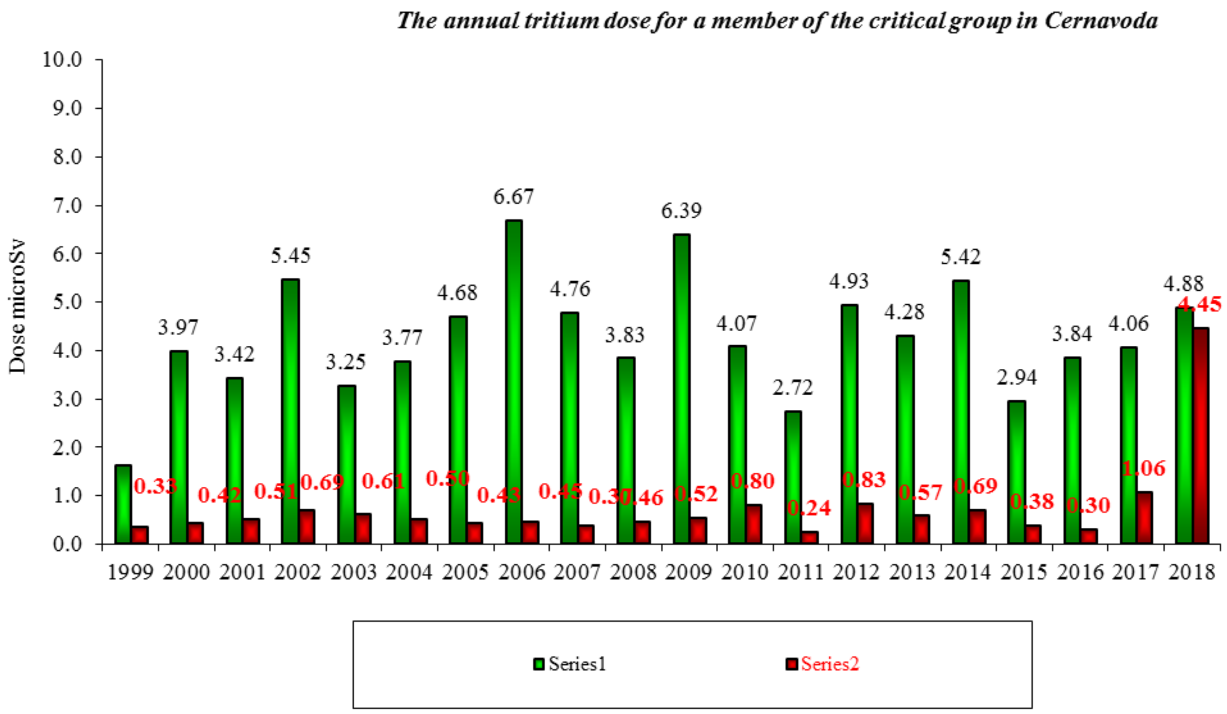


Fig. 15.7

Fig. 15.7 shows the evolution of the doses received by the population of Cernavoda, due to the presence of tritium in the surrounding environment, calculated with the results of both programs (effluents monitoring and environmental monitoring program). As can be seen, the doses calculated based on the tritium emissions data are with one order of magnitude higher than those calculated based on the tritium concentrations measured in the environmental samples. This demonstrates not only the doses to population are below the dose constraint for Cernavoda NPP (with one to two orders of magnitude), but also the models used for calculating the Derived Emission Limits are conservative.

The results of the monitoring programs deployed by Cernavoda NPP are verified for their validity, by the different responsible Romanian authorities. According to the legislative framework in Romania, the main ministries and organizations having responsibilities in the field of environmental radioactivity monitoring (including the surveillance of food stuffs) are:

- Ministry of Environment and Climate Change, which organizes the Environmental Radioactivity Monitoring Network on the Romanian territory;
- Ministry of Health, which organizes the epidemiological monitoring system of the health condition of the occupationally exposed personnel and of the hygiene

conditions in nuclear installations, follows up the influence of nuclear activities on the population health;
- National Commission for Nuclear Activities Control (CNCAN);

According to the Law on the safe deployment, regulation, licensing and control of nuclear activities, CNCAN is empowered to control the licensee, in order to verify the compliance with the national legal requirements and licensing conditions. In addition, the Requirements for the monitoring of radioactive emissions from nuclear or radiological facilities stipulate that in the case of nuclear installations that may have a significant environmental impact, CNCAN may deploy its own environmental radioactivity monitoring program in the vicinity of the nuclear installation, in order to check the results supplied by the licensee and to confirm that public exposure to radiations is maintained below the dose constraints imposed by CNCAN.

15.2.3.2 Impact of Cernavoda NPP operation on biota

The concept of sustainable development confers the environmental protection the same status with that of the human protection, based on the idea that we first need to protect the environment in order to protect the man (Protection of the environment from the effects of ionizing radiation, IAEA-TECDOC-1091, International Atomic Energy Agency, Vienna). In this context, a study was conducted on the impact the operation of the two units may have on living organisms in the area of Cernavoda NPP in 2009-2011.

The study focused on the assessment of the chemical and radiological impact on flora, fauna and the environment (water, air, soil, sediment), based on over 80 types of complex analysis (X-ray fluorescence, GCMS, LSC, HPLC, genetic analysis).

During next years the decision to extend the monitoring regarding the impact nuclear power production has on the environment, by including plants and animals, was made based on the new approach regarding environmental protection, in which other critical aspects except man are taken into consideration.

As consequence, Cernavoda NPP implemented a continuous project of monitoring the impact on aquatic and terrestrial biota, conducted by certified laboratories, which proves that Cernavoda NPP Operation has not any significant hazardous effect on environment.

15.2.4 Optimization of Radiation Protection

15.2.4.1 Radiation Workers

In accordance with the regulatory requirements in BRRS, the licensee shall take all the necessary actions to optimize the radioprotection, by ensuring that all exposures to ionizing radiation, including the potential ones, are maintained at the lowest reasonably achievable level (ALARA principle).

In order to keep the radiation exposures as low as reasonably achievable, the NPP has applied various measures, including design measures, procedural control of activity performance, planning for unusual situations, personnel training and qualification in radiation protection, specific procedures, such as:
- ALARA process
- Radiation Work Permit process

In order to implement the ALARA process, two committees have been established at Cernavoda NPP:

- Technical ALARA committee, which analyses and approves the action plans to reduce the exposures at the departments level, proposes the ALARA objectives and targets at NPP level, periodically approves the ALARA results and recommends programs to improve the ALARA process; this committee is led by the Station Health Physicist and it is composed by the Plant ALARA Coordinator and ALARA Coordinators of the main departments of the plant: Operations, Maintenance, Fuel Handling, Health Physics, Chemical Laboratory, Non Destructive Examinations Laboratory);
- Plant ALARA committee, which approves the ALARA objectives and targets at NPP level, analyses the evolution of ALARA indicators and proposes actions for correcting and changing those objectives, analyses the opportunity to implement specific ALARA actions; this committee is led by the Plant Manager and is composed by the Technical Manager, Production Manager, Station Health Physicist, Operations, Maintenance and Planning Superintendents, Plant ALARA Coordinator.

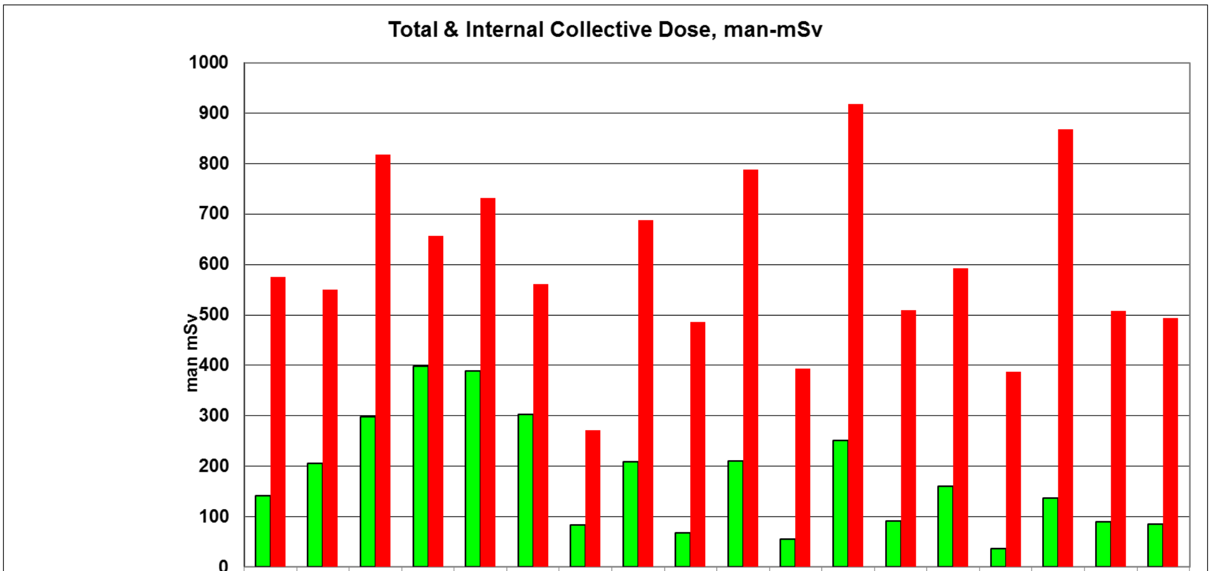
A significant improvement of ALARA policy was done at NPP Cernavoda by implementing an effective ALARA process. Senior managers are directly involved in ALARA process as members of the ALARA committee. This committee is responsible for approving and reviewing the station ALARA long term plan. It meets periodically to review the performance of the facility in relation to radiation protection, to approve performance indicators and to periodically analyze plant performances, to evaluate suggestions for reducing doses and to review high collective dose jobs.

Also, a long term reduction dose plan is approved by ALARA Committee as a tool of ALARA policy; this plan integrates CNE Cernavoda radiation protection projects in order to optimize occupational exposures and reduce environment impact. This plan includes the main actions for keeping doses ALARA based on the newest radiation protection search results and, the best industry good practices. This plan is revised annually.

Another practical measure to control the radiation exposures is the Radiation Work Permits process, through which the activities deployed in radiological risk areas are identified, so that the radiological conditions are assessed, in order to establish and implement the adequate radioprotection measures. If the estimated collective dose for a certain work exceeds certain established levels, supplementary analyses and approvals are needed to deploy the respective work. For example, if the estimated collective dose is higher than 5 man*mSv, the ALARA coordinator of the compartment must issue an ALARA action plan, which must include all the supplementary radioprotection measures, the progress of the work, the preliminary requirements and the techniques for controlling the exposure. During the progress of the work, the collective dose is monitored against the estimated one, so that the necessary measures for optimizing the exposures could be taken in due time. After completion of the work, an analysis of the estimated against received values must be done, in order to identify the efficiency of the dose reduction and special working techniques, the problems occurred and the lessons learned, the probable causes for significant discrepancies between received and estimated collective doses, if there is the case.

Fig.15.8 shows the evolution of the annual collective total and internal doses registered at Cernavoda NPP. The maximum value (918 man·mSv) was registered in 2012 and it was caused by the extended 38 days outage at Unit #1, two unplanned outages at Unit #1 and three radiological events that had a significant impact on individual and collective doses.

The increasing number of employees under dosimetric surveillance did not cause a proportional increase of the collective doses and of the number of exposed workers with doses above recording level. It should be noted that the 388 man mSv for the year 2015 and 918 man mSv for 2012 represent the collective doses for both Unit 1 and Unit 2, with extended planned outages in Unit 2 (2015) and Unit 1 (2012). The actual levels of total effective doses due to internal and external exposures reveal the effectiveness of implementation of the Radiation Safety Policies and Principles, based on the ALARA principles.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Internal collective dose	141.42	206.43	298.02	398.26	389.3	302.27	83.34	209.3	67.6	210.3	56.2	250.8	92.3	160.3	36.4	137.1	89.57	85.6
Collective dose	574.86	550.48	818.28	656.71	731.59	561.06	270.83	688.6	485.3	787.3	392.98	917.9	509.1	592.3	388.1	867.9	507.5	494.03

Fig.15.8

15.2.4.2. Public

According to art.18 of NFSR, the dose constraints for the public, established by CNCAN, shall be used as superior margin in the radioprotection optimization process. This must be done by using the dose constraint into the calculations of Derived Emission Limits (DEL), as stipulated by the new CNCAN Requirements for Limiting Radioactive Discharges into the Environment (issued in 2005).

For this reason, the NPP reviewed in 2007 its DELs, which have been fully implemented by the 1st January, 2008, the major changing being the use of the dose constraints established by CNCAN for Cernavoda NPP (0.1 mSv/year for each unit and 0.05 mSv/year for Spent Fuel Intermediate Dry Storage facility) instead of the legal dose limit for population (1 mSv/year) in the calculation of DELs.

As a consequence of recalculation of DELs, and in order to accomplish the requirements of the new CNCAN Requirements for the Monitoring of Radioactive Emissions from Nuclear and Radiological Installations and the Requirements for the Environmental Radioactivity Monitoring around Nuclear and Radiological Installations, the NPP also revised in 2007 the Radioactive Release Monitoring Program and, respectively, the Environmental Radioactivity

Monitoring Program. Both programs are fully implemented since 2008.

15.2.4.3 Detritiation project

The design features of a CANDU reactor for ensuring the control of tritium can be considered as conceptual barriers which prevent and minimize the occupational exposures to tritium and the tritium emissions into the environment.

The fundamental method to mitigate both the occupational and the public exposure to tritium consists in reducing the tritium concentrations into the heavy water by tritium removal („detritiation”), in this way the consequences of heavy water leaks being reduced at their source. The efficiency of the following barriers is decreasing in this order: tightening of leaks, vapours recovery, confinement, purging.

In this respect, Cernavoda NPP initiated a project for a tritium removal facility for Unit 1 and Unit 2, and eventually, with extension possibilities for Unit 3 and Unit 4.

The main objectives of the project are:

- to reduce and maintain the tritium concentration in moderator heavy water at about 10 Ci/kg;
- to reach the above mentioned target in 3 – 4 years of operation;
- upgrading heavy water to about 99.95%.

The licensing basis are already agreed with CNCAN, the conceptual design and the associated safety documentation are complete and accepted by CNCAN who assessed the project as licensable. The project received the necessary approvals from SNN Board of Directors and General Shareholders Assembly and the next step is implementation, which will consist of obtaining the licenses and contracting the detailed design, construction and commissioning.

15.3 Significant developments for the last reporting period

The main significant developments for the last reporting period are summarized as follows:

- CNCAN has revised the regulatory framework for radiological protection and has issued the Basic Requirements on Radiological Safety in 2018, to align with the latest international standards and European directive for protection against the dangers arising from exposure to ionizing radiation
- Challenging specific individual dose targets are established every year for working groups having a significant contribution to collective exposure at Cernavoda NPP.
- The Radiation Monitoring System (RMS) implemented at Cernavoda NPP, which integrates a remote Tritium in Air Monitoring (TAM) system, has been finalized with the unique feature to estimate heavy water leak rate in different locations. The system provide on line access to radiation fields information in several location of the plant, including emergency control centers.
- The Environmental Control Laboratory of Cernavoda NPP started in 2018 a supplementary program for organically bound tritium (OBT) analysis in fish, grass, wheat and potato samples, after a 5-year experience of participation at international intercomparison exercises for OBT analysis.

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.

16.1 Description of the legislative and regulatory framework for on-site and off-site emergency planning and preparedness

Emergency preparedness and response in Romania is organized in accordance with the Law 15/2005 for the approval of the Governmental Ordinance no. 21/2004, regarding the National System for the Management of Emergencies, with subsequent modifications and completions. Other applicable regulations (Governmental Decisions - GD) are mentioned as follows:
- GD no. 94/2014 regarding the organization, functioning and componence of the National Committee for Special Emergency Situations (CNSSU)
- GD no. 1491/2004 for the approval of the frame Regulation on the structure, attributions, functioning and endowment of the committees and operative centres for emergencies with subsequent modifications and completions;
- GD no. 1492/2004 on the organizational and functioning principles and attributions of the professional emergency services with subsequent modifications and completions;
- GD no. 557/2016 regarding the management of various types of risk; this GD outlines the main support functions which the ministries, state authorities and non-governmental organizations have to perform in order to prevent and manage emergency situations.

The national emergency response scheme, as established by this legislation, is described in section 16.2.2.

The Law no. 111/1996 on the safe deployment, regulation, licensing and control of nuclear activities stipulates, as one of the licensing conditions, the obligation of the applicant to institute and maintain his own approved system for the intervention in case of nuclear accidents. Also, the licensee has the obligation and responsibility to take all necessary measures in order to ensure and maintain his own emergency plan in case of nuclear accident, and the development of his own system of requirements, regulations, and instructions ensuring the deployment of licensed activities without unacceptable risks of any kind. The responsibility for nuclear damage caused during or as a result of an accident that might occur by deployment of the activities under the license or of other activities resulting in the death, damage to the corporal integrity or health of a person, destruction, degradation, or temporary impossibility of using some goods rests entirely upon the licensee, under the terms established by law and by international commitments Romania is a party to.

The co-ordination of the intervention preparations in case of nuclear accident shall be ensured by the National Committee for Special Emergency Situations (CNSSU) within the Ministry of Internal Affairs (MAI), in co-operation with all specialized bodies of the central and local public administration with powers in these matters. The intervention plan in case of nuclear accident for the site of nuclear installations shall be developed by the licensee, together with all the responsible central and local public authorities and specialized organizations; the on-site intervention plans shall be approved by CNCAN, which has also the responsibility to evaluate periodically and control the applicability of the plan.

The off-site response in case of radiological emergencies, caused by nuclear accidents in NPPs located on the territory of other states that may affect the Romanian territory, by transboundary effects, as well as the off-site response for nuclear plants on the Romanian territory are prepared in accordance with the national nuclear emergency plan, developed by the General Inspectorate for Emergency Situations (IGSU) within MAI and CNCAN. This national plan is submitted for approval to CNSSU and its applicability has to be periodically assessed and controlled by IGSU and CNCAN. The central and local public authorities with powers in the field of preparedness and practical response to a nuclear accident are responsible for developing their own plans correlated with the national nuclear response plan. These plans must be approved by the respective authorities, with the advice of IGSU and CNCAN, and their applicability has to be periodically assessed and controlled by these authorities.

According to art. 5 of the Law, CNCAN is empowered to issue regulations for the detailed specification of the general requirements on intervention in case of nuclear accidents. In this respect, the current specific requirements are provided in the following regulations, issued in alignment with the latest applicable international standards and European directives and reflecting the lessons learned from the Fukushima accident:

- Basic Requirements on Radiological Safety (BRRS, 2018);
- Regulation on the management of emergency situations specific to nuclear or radiological risk (2018);
- Regulation on the prevention, preparedness and response in case of emergency situations for the emergency preparedness categories I, II and III (2018);
- Regulation on the prevention, preparedness and response in case of emergency situations for the emergency preparedness categories IV and VI (2018);
- Fundamental Nuclear Safety Requirements (NSN-21, 2017);
- Nuclear Safety Requirements on Preparedness for Response to Transients, Accidents and Emergencies at Nuclear Power Plants (NSN-07, 2014).

The regulations include specific requirements regarding the radiation protection in interventions, stipulating that, for obtaining a license from CNCAN, for any nuclear activity, the applicant shall take into consideration all types of radiological emergencies which could arise from the practice, assesses the spatial and temporary distribution of radioactive substances dispersed in case of radiological emergencies and, consequently the corresponding potential exposures. Based on these evaluations, the applicant shall elaborate an adequate intervention plan, at all necessary levels, commensurate with the extent of all possible types of radiological emergencies.

The licensee is responsible to ensure that intervention plans are tested to an appropriate extent at regular intervals. Also, the licensee is responsible to notify immediately any radiological emergency occurring on site and to take all the necessary measures to reduce the consequences of the radiological emergency. For the adequate accomplishment of its own tasks concerning the intervention, the licensee has to perform an initial provisional assessment of the circumstances and the consequences of the radiological emergency and to communicate it immediately to the competent authorities. As a general principle, the intervention has to be focused on the source, to reduce or stop the direct radiation and radioactive emissions, to reduce the transfer of radioactive substances to the environment and to the individuals, to reduce exposure and organize the treatment of victims.

In accordance with the regulations, the analysis, approval and revision of the on-site emergency intervention plan shall be controlled and the responsible public authorities shall have the possibility to analyze each revision of the plan, to ensure the coordinated reaction to any emergency situation and at any moment.

16.2 Implementation of Emergency Preparedness Measures, Including the roles of the Regulatory Authority and of the other organizations

16.2.1 Classification of emergency situations

In the On-site Emergency Plan of Cernavoda NPP, the emergencies are classified as follows:

- Alert;
- Facility Emergency;
- Site Area Emergency;
- General Emergency.

As stipulated in the On-site Emergency Plan of Cernavoda NPP, in case of radiation emergencies the response actions should begin without any delay and be coordinated from the start. To facilitate this, an event classification system was established, in order to predefine the response actions for each emergency class. The events are classified on the basis of the actual or potential consequences of an incident for the public, environment, station personnel and property.

The classification criteria at Cernavoda NPP are the following:

- station / systems / personnel status;
- radiation hazards.

In order to classify the events, the radiation hazards criteria are applied in those cases when the dose rates increases are associated with the station / systems / personnel status impairment.

Based on the station / systems / personnel status, the events are grouped in:

a) Events in operating at power or zero-power hot mode. The classification of the events in operating at power or zero-power hot mode is given in Appendix 16.1 and includes radiation events at nuclear systems, grouped upon the safety function impairment:
   - loss of reactivity control;
   - inadequate fuel cooling;
   - containment isolation system impairment.

b) Events in zero power cold or HTS drained to the header level. The classification of the events in zero power cold or HTS drained to the header level is given in Appendix 16.2 and includes radiation events at nuclear systems, grouped in order of loss fission product barriers.

c) Events free of the reactor state. The classification of the events free of the reactor state is given in Appendix 16.3 and includes:
- radiation events at Spent Fuel Bay, Shielded Work Station or Intermediate Dry Spent Fuel Storage;
- security events;
- external events;
- other events, such as: Main Control Room unavailability events, fires, chemical incidents, medical incidents, etc.

Based on the radiation hazards, the events are classified taking into account:
- the radiation levels expressed in terms of external dose rates, determined on the base of the surveys and sampling performed by the on-site and off-site survey teams and On-site/Off-site Gamma Monitoring System readings;
- the total activity released to stack, determined on the base of laboratory analyses of Gaseous Effluent Monitors filters and Gaseous Effluent Noble Gases Monitor readings;
- the activity in the containment, determined on the base of results provided by the Post Accident Sampling System;
- tritium dose rates in normally occupied areas of the station.

The classification of the events based on the radiation hazards is given in Appendix 16.4.

Appendix 16.1 – Emergency classification in operating at power or zero-power hot mode

For the following plant conditions*:*	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
LOSS OF REACTIVITY CONTROL				
Early Loss of Core Structural Integrity *Any event at full power that leads to an imbalance between power generated and power removed by the coolant. All the control and shutdown systems are assumed to fail. This includes the failure of RRS with both the setback and stepback functions, the failure of SDS#1 and the failure of SDS#2. The shutdown of the reactor is caused by moderator displacement as a result of steam discharged from the failed fuel channels. The discharge of superheated steam from many ruptured channels can damage calandria vessel and pressurize containment to failure.*	• Fast reactivity increase (severe power excursion) caused by LOCA • Loss of reactivity control • Decreased coolant flow (loss of HTS pumps) + failure to shutdown the reactor.			

For the following plant conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
INADEQUATE FUEL COOLING				
Late loss of core structural integrity at high HTS pressure *Any event, which will lead to loss of all heat sinks with the reactor at decay power. HTS is initially intact with decay heat being removed for a period of time by the boiling of the steam generators inventory (steaming through the MSSV) and by boiling the HTS coolant inventory (steaming through the LRV). The HTS pressure remains near the LRV setpoint through the boil-off period (10 MPa). Some high elevation channels void sufficiently to superheat to 600^{o}C.* *The pressure tube wall attempts to strain radially into contact with its calandria tube but fails because a coolant stratification-induced temperature gradient combined with high internal pressure cause a highly localized thinning of the pressure tube. This lead to channel failure and the residual HTS coolant being discharged into calandria vessel. Calandria vessel integrity will be maintained until moderator inventory and shield tank inventory will be boil-off. After these inventories are depleted the calandria vessel disassembly will begin.*	• Loss of feedwater (main and auxiliary) + loss of SDCS + loss of EWS + loss of ECCS + loss of moderator. • Loss of feedwater (main and auxiliary) + loss of EWS + loss of service water (RCW+ RSW). • Loss of class IV + loss of class III (DG's) + loss of EPS	• Loss of class IV + loss of class III (DGs) + EPS reduced to a single source		
Late loss of core structural integrity at low HTS pressure *This scenario is similar with the one presented above until the fuel channels are melted and drops on the bottom of the calandria vessel. Starting from this point forward accident progression within calandria vessel can be terminated by successful initiation of high and medium pressure injection stages of ECCS into the core, prior to the calandria vessel failure. Molten corium is present but is confined to the bottom of the calandria vessel. This scenario does not have the potential for the generation of non-condensable and flammable gases due to the molten–corium -concrete*	• Loss of feedwater (main and auxiliary) + loss of SDCS + loss of EWS + loss of moderator + loss of ECCS heat exchanger as a heat sink (ECCS provide make-up but the ECCS heat exchanger is unavailable as a heat			

For the following plant conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
interactions.	sink due to loss of service water – RCW and RSW). • LOCA + loss of ECCS + loss of moderator.			
Loss of core cooling requiring the moderator as a heat sink within 500 seconds *This type of scenario is caused by any LOCA which requires automatic initiation of ECCS combined with failure of ECCS but with the moderator available as a heat sink. For this scenario, some pressure tubes may strain and contact their associated calandria tubes, in which case the moderator provides a heat sink. Extensive fuel sheaths failures and zirconium – steam reaction is expected in the broken loop. Fuel melting does not take place.*	• Any LOCA which requires automatic initiation of ECCS + loss of ECCS and failure of containment isolation but with the moderator available and required as a heat sink within 500 seconds following reactor trip	• Any LOCA which requires automatic initiation of ECCS + loss of ECCS but with the moderator available and required as a heat sink within 500 seconds following reactor trip		
Loss of core cooling requiring the moderator as a heat sink after 500 seconds *This type of scenario is caused by any LOCA accident, which requires manual initiation of ECCS combined with failure of ECCS but with the moderator available as a heat sink.*	• Any LOCA which requires manual initiation of ECCS + loss of ECCS and failure of containment isolation but with the moderator available as a heat sink and required as a heat sink after 500 seconds following reactor trip.	• Any LOCA which requires manual initiation of ECCS + loss of ECCS but with the moderator available as a heat sink and required as a heat sink after 500 seconds following reactor trip.		

For the following plant conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
Loss of cooling/Inadequate cooling in one or more core passes following a large LOCA with successful initiation of ECCS *This type of scenario is caused by Large LOCA*			• Large LOCA	
Single channel LOCA with containment pressurization *This type of scenario is caused by out-of-core events with fuel ejection from one channel on the reactor building floor*			• End Fitting Failure. • F/M-induced LOCA with fuel ejection into containment. • F/M-induced LOCA due to F/M-induced end fitting failure.	
Single channel LOCA with no containment pressurization *This type of scenario is caused by in-core events with the fuel ejected from one channel into the moderator.*			• Severe channel flow blockage. • Pressure tube rupture and fuel ejection, • Inlet feeder break.	
Loss of cooling to the Fuelling Machine *This type of scenario is caused by loss of cooling to Fuelling Machine, which transfers maximum eight fuel bundles.*			• F/M-induced LOCA with no fuel ejection. • Fuelling Machine while “OFF” reactor.	

For the following plant conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
			• F/M D2O system failures.	
Loss of HTS integrity/Small LOCA with successful initiation of ECCS *This type of scenario is caused by a break in the HTS that results in operation of ECCS but that does not cause fuel damages is nevertheless considered to have potential for significant economic consequences. Such an event results in the release of radionuclides (tritium, noble gases, radioiodines) from the coolant.*			• Any small LOCA which requires automatic initiation of ECCS with successful initiation of ECCS	
Small LOCA without automatic initiation of ECCS *This type of scenario is caused by a break in the HTS that not results in operation of ECCS.*				• Small LOCA without automatic initiation of ECCS
Steam Generator Tube Failure (SGTF)		• SGTF + failed fuel + one way open to discharge in the atmosphere (MSSV / ASDV)	• SGTF + failed fuel	• SGTF
Deuterium deflagration in cover gas and/or release of moderator into containment (fuel cooling is maintained) *This type of scenario is caused by events that may result in a release of moderator fluid into containment with associated release of tritium.*			• Draining of moderator into containment with D_2>4% in cover gas and presence of ignition source.	

For the following plant conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
FAILURES OF CONTAINMENT ISOLATION SYSTEM				
Any incident, which requires automatic containment isolation, combined with failures of containment isolation system.	• Large LOCA + failure to isolate containment • End Fitting Failure + failure to isolate containment			

Appendix 16.2 – Emergency classification in zero power cold or HTS drained to the header level

For the following entry conditions*:*	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
Impaired decay heat removal in cold plant conditions	Core damage is likely or has already occurred and containment impaired	Inability to provide alternative cooling to the core (no SDC, no boilers, no low pressure ECC, and unable to operate HTS pumps)	Single forced cooling method unavailable	Decay heat removal reduced to a single system
Fuelling Machine Induced LOCA (cold plant conditions)			F/M-induced LOCA with no fuel ejection.	

Appendix 16.3 –Classification of the events free of the reactor state

For the following entry conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
SPENT FUEL HANDLING EVENTS				
Loss of control of fuel or radioactive waste during movements	Airplane crash on the Intermediate Dry Storage Facility	• Fall of the transfer flask loaded with a basket on the storage platform (the basket leaves without biological protection). • Fall of a basket during storage cylinder loading. • Fall of the transfer flask loaded with a fuel storage basket (60 fuel bundle) during the transfer to Intermediate Dry Spent Fuel Storage	• Fall of a fuel storage basket (60 fuel bundle) in Spent Fuel Bay or Intermediate Dry Spent Fuel Storage.	• Fall of a fuel bundle / a fuel tray (24 fuel bundle) in Spent Fuel Bay.
SECURITY EVENTS				
Security events may have consequences for the population, environment, site personnel and material goods	Security event resulting in loss of the ability to monitor and control safety functions needed to protect the core or containment	Security event resulting in damage prevention of the normal, abnormal or emergency operation of the plant	Security event potentially affecting safe system operation	Uncertain security condition

For the following entry conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
EXTERNAL EVENTS				
Natural disaster or other major event such as: • Severe weather phenomena (winds, lightning, tornadoes, extreme temperatures) • Earthquake • Floods • Fires from natural sources • External events caused by human activities (industrial plants, road, rail or water vehicles loaded with explosives, military activities)		Natural disaster or other major event resulting in damage to safety systems or access to safety systems or affecting long term operation	Natural disaster or other major event resulting in events beyond the design basis of the plant	Natural disaster or other major event resulting in actual or potential loss of access to the site / potential loss of communication with the site for an extensive period of time
OTHER EVENTS				
	Fires with potential damage of any safety system simultaneously with failures of containment isolation system	Fires with potential damage of any safety system simultaneously with failures of ECC	• Fires with potential damage of any process system • Main Control Room Unavailability Events	• Fires without potential damage of process systems • Chemical spill • Medical incidents • Minor incidents with radiation consequences for the station personnel (ex.: small loss of D_2O HTS or moderator, incidents involving radioactive sources). • Incidents during the radioactive waste transfer to Intermediate Solid Radioactive Waste Storage

Appendix 16.4 – Emergency classification based on the radiation hazards

For the following entry conditions:	Declare a General Emergency if:	Declare a Site Area Emergency if:	Declare a Facility Emergency if:	Declare an Alert if:
External dose rate ($\dot{H}_{ext}$) in normally occupied areas of the station*:	$\dot{H}_{ext}$ > 10 mSv/h	1 mSv/h < $\dot{H}_{ext}$ <10 mSv/h (potentially lasting several hours)	0.1 mSv/h < $\dot{H}_{ext}$ < 1 mSv/h (potentially lasting several hours)	—
External dose rate ($\dot{H}_{ext}$) at off-site / beyond the site boundary:	$\dot{H}_{ext}$ > 1 mSv/h	0.1 mSv/h < $\dot{H}_{ext}$ < <1 mSv/h	0.01 mSv/h < $\dot{H}_{ext}$ <0.1 mSv/h	—
Total activity released to stack (confirmed release), averaged on 15 minutes, which lead in 1 hour the off-site doses:	H > 1 mSv	H > 0.1 mSv	—	—
Total activity in the containment, based on the results from Post-Accident Sampling System:	Λ_{GN} > 9E12 Bq	4.5E11Bq < Λ_{GN} < 9E12Bq	7E6 Bq < Λ_{GN} < 4.5E11 Bq	—
	Λ_{I} > E11 Bq	6E9 Bq < Λ_{I} < E12 Bq	32E4 Bq < Λ_{I} < 6E9 Bq	—
Tritium dose rate ($\dot{H}_{T}$) in normally occupied areas of the station*:	—	—	$\dot{H}_{T}$ > 1mSv/h (which remains a significant period of time - hours)	0.05 mSv/h < $\dot{H}_{T}$ < 1 mSv/h (which remains a significant period of time - hours)

*Note: Areas (from Radiological Areas 2 and 3) where in normal conditions the dose rates are lower than 10 µSv/h.

16.2.2. Overall national emergency preparedness structure

The National System for the Management of Emergencies is composed of three types of structures:

- the decisional structure – the committees for emergencies;
- the executive structure – the inspectorates for emergencies;
- the operational structure – the operative centres for emergencies.

All the decisional, executive and operational structures are established on three levels: national, county and local.

As a decision structure, at national level is organized the National Committee for Special Emergency Situations (CNSSU). The CNSSU is set-up under the co-ordination of the Prime Minister and managed by the Minister of Internal Affairs (MAI). All the ministerial, county and local committees are subordinated to CNSSU. The County / Local Committees for Emergencies are directed by the county Prefect / local mayor.

As an executive structure, at national level is established the General Inspectorate for Emergency Situations (IGSU), a specialized organization of MAI. IGSU has the responsibility of permanent co-ordination of the prevention and management of emergency situations, at national level. At county level, there are established County Inspectorates for Emergencies, acting as public professional emergency services.

Inside each Inspectorate for Emergency Situations is set-up an Operative Centre for Emergencies, with permanent activity, ready to activate the emergency organization in case of an accidental event. These Operative Centres for Emergencies are receiving notifications for all types of emergencies, including radiation events.

Also, the responsible organizations at national level are operating such Operative Centres for Emergencies, in accordance with the legal provisions in their field of activity. As an operational structure, at national level is functioning the National Operative Centre of IGSU.

In order to fulfil the legal responsibilities in case of a nuclear accident or radiological emergency, CNCAN has established its own Emergency Response Centre (ERC), as part of the National System for the Management of Emergencies.

CNCAN – ERC acts as a support centre performing technical analysis and prognosis of the emergency situations with focus on the nuclear safety, radiation protection and radiological consequences, in nuclear and radiological emergency situations:

- independent analysis,
- technical recommendations in the nuclear safety field,
- technical recommendations in the radiation protection field,
- environmental radioactivity measurements (field and laboratory measurements).

CNCAN – ERC is the national contact point in relation to any type of radiation emergency. As part of the National System, CNCAN-ERC is communicating with IGSU Operative Centre and with other operative centres of public authorities.

In accordance with the legislation, the Ministry of Internal Affairs (MAI) is responsible for the management of nuclear and radiological emergencies, IGSU and CNCAN being the national competent authorities in case of nuclear accident or radiological emergency. At local level, the intervention is coordinated by the local committees for emergencies and performed by the local response forces. When the emergency situation cannot be solved by the local authorities, the national level is activated, in order to support the local intervention. Written agreements and protocols are in place between the responsible organizations, at local and central level, for common activities and exchange of information in emergency situations.

In accordance with the provisions of Law 15/2005, CNCAN, as national competent authority in the nuclear field, has the following specific functions in the National System for the Management of Emergencies:

- Monitoring of specific dangers and risks, together with their associated negative consequences, and
- Informing, notifying and alerting.

CNCAN has, in the field of radiation emergency preparedness and response, the following responsibilities:

- to notify an emergency to national and international responsible organizations;
- to create, update and disseminate information inside the country and outside (through IAEA and through bilateral agreements with other states) on the overall view of the safety status of the nuclear installation / radiological facility and on the radiological situation;
- to perform technical assessments and to advise the CNSSU representatives (the decision makers at national level) on the safety status of the nuclear installation / radiological facility;
- to give technical advice to and supervise the public authorities and the licensees on nuclear/ radiological safety issues;
- provide advice to licensees, as necessary, on additional steps to be taken to mitigate the consequences of the accident and avoid harm to the public and the environment;
- recommend to CNSSU representatives the protective actions for the population in case of an emergency;
- assess and advise CNSSU representatives on the appropriate information which are to be distributed to the media and the general public for accurate, timely and comprehensive information regarding the emergency;
- assess and advise CNSSU representatives on the appropriate long term post-emergency protective actions;
- advice for protective measures for industry, trade, traffic and customs.

The response organizations have the following responsibilities:

- to elaborate and revise to date an adequate emergency plan;
- to assure by means of laws, Governmental Ordinance, decrees, the legal basis for protection of the population, environment and property, medical care, financial compensations, etc. in emergency situations;
- to establish and maintain a proper structure of the intervention sources able to: advise on nuclear safety and radioprotection, sample and analyze samples, keep in contact with police, army and fire fighting forces, keep contact and receive advice from water management bodies, agriculture produce control bodies, medical services, meteorological forecast facilities.

- to organize and maintain an emergency co-ordination centre equipped with technical means for the expertise of the emergency and sufficient communication means;
- to organize exercises and drills, to maintain the level of personnel training and equipment availability for emergency situations;
- to establish levels for the triggering of the emergency in case of transboundary emergencies.

16.2.3. On-Site and Off-Site Emergency Intervention Plans

The objective of the On-site Radiation Emergency Plan along with its supporting documents is to ensure effective emergency preparedness and response to emergency situations at the nuclear installation. The purpose of the On-site Radiation Emergency Plan is to identify the essential elements of a response to a radiation emergency and to describe in general terms the measures required to control and mitigate the radiological accident consequences within the site and to minimise the off-site effects.

The On-site Radiation Emergency Plan emphasizes the immediate on-site response actions. Also, it does cover the off-site emergency for the first few hours of the radiation incident having an impact on the public and the environment. The plan includes the classification of radiation incidents, the evaluation of on-site incidents and the response actions. It identifies also the material and human resources necessary to implement these actions, and defines the organization and the responsibilities for the personnel involved for every phase of an incident. The On-site Radiation Emergency Plan is implemented through the On-site Radiation Emergency Procedures.

In the last reporting period many components of the Emergency Preparedness and Response Process were upgraded. Examples of upgrades and improvements are given as follows:

- revision of the On-site Emergency Plan;
- set-up of an Intervention Support Center in the Simulator;
- a software application for dose assessment for the intervention team members in case of severe accident has been developed;
- the communication groups by the TETRA radio stations have been supplemented with a dedicated group for the monitoring teams;
- a contract for psychological counseling and psychotherapy services in case of emergency was concluded.

The on-site emergency organization ensures a complete on-site response to emergency situation as well as covering the off-site emergency responsibilities of Cernavoda NPP. The size of the on-site emergency organization depends on the type of the emergency event and its evolution in time.

At the first indications of an event, the Station Shift Supervisor has the responsibility to identify the causes and effects of the emergency situation and anticipates its evolution. The transients without radiation consequences are not taken into account by the on-site emergency plan, being handled by the application of specific Abnormal Plant Operation Procedures (APOP).

The class of the event is established by the Shift Supervisor after assessing the station / systems / personnel status or the radiation hazards. The site personnel warning (through the

Public Address System and through the site siren, depending on the incident class) will initiate the emergency response.

In case of emergencies which do not need the OSECC (On-Site Emergency Control Centre) to be activated (alerts) the response activities are directed and coordinated from the Main Control Room and they are performed by the Response Team formed by shift personnel.

In case of emergencies which do need the activation of OSECC, the Shift Supervisor will notify the emergency management and support personnel and he will accomplish the Emergency Manager duties till the authorized person will take over. Taking over the Emergency Manager responsibilities will occur in the same time with the OSECC activation, meaning at the moment when the Command Unit (Emergency Manager, Emergency Technical Officer, Emergency Health Physicist and Emergency Administrative Officer) will be present in the OSECC. The necessary time to set-up the OSECC is of 15 minutes during normal working hours, and of 2 hours, after normal working hours.

The purpose of the emergency operation activities is to bring back the station in a safe state, to ensure an adequate fuel cooling and to stop the radioactive releases from the station. These are realized by applying the adequate emergency operating procedures.

In order to prevent an escalation of the threat and to mitigate the consequences of any actual radioactive release or radiation exposures, the Technical Support Group will provide technical advice in a timely manner to the Emergency Manager and to the Shift Supervisor.

In case of radiation emergencies with off-site effects, Cernavoda NPP is responsible for initiating protective actions for the public, by notifying the public authorities and making recommendations on protective measures for the population. The responsibility to decide and implement these recommendations belongs to public authorities involved in the off-site intervention.

In all phases of an emergency, notification forms are sent by fax to the public authorities involved in the intervention off-site, as follows:

- the “Radiation Emergency Notification” form, sent as soon as possible after the declaration of the incident;
- the “Source Term Description” form is used only if the containment is boxed-up; the form is sent when enough data are available and, after this, each hour or when situation changes;
- the “Radiological Information” form is sent when a radiological release from the containment is in progress and data from the stack and/or from the On-site/Off-site Monitoring Team are available; after that, it is sent each hour or when the situation changes;
- the “Radiation Emergency Termination” form is sent when the Emergency Manager declare the termination of the emergency.

In order to provide the decision makers with the necessary information to establish the protective actions which should be implemented, Generic Criteria (GC) have been developed based on projected doses and Operational Intervention Levels (OILs) have been developed derived from GC.

GC and OILs are shown in Appendix 16.5 and 16.6.

The projected doses are calculated:

- during the planning process, for case of emergencies followed by an immediate radioactive release from the containment. The projected doses are calculated for a zone of 15 km radius around the plant (Urgent protective action planning zone), in the most unfavourable meteorological conditions for dispersion (F stability class). The protective actions are established comparing the calculated projected doses with GC. These protective actions will be recommended to public authorities immediately after the assessment and classification of the incident;
- during the emergencies, taking into account the current radiological conditions in the containment and the meteorological conditions affecting the dilution of the release; the protective actions established by comparing the calculated projected doses with GC are used to provide recommendations to public authorities or to prepare the containment depressurization strategy.

Protective actions based on projected doses are shown in Appendix 16.5.

During emergency situations, on site / off-site radiological hazards are measured in order to quickly decide the need to recommend protective actions. The protective actions are established by comparing the measured radiological hazards with the Operational Intervention Levels (OILs) calculated during the emergency planning process based on GC.

The protective actions based on the measured radiological hazards are shown in Appendix 16.6.

In case of emergency, the dose limits applicable to emergency response personnel are replaced by the reference levels given in Appendix 16.7. Every effort will be made to ensure that these levels are not exceeded. Exceeding these levels can be done only the Emergency Manager approval and only in circumstances where the expected benefits are clearly higher than the health risks of the exposed personnel.

Intervention personnel may exceed these limits so long as for activities that are likely to exceed the limit of 50 mSv they act as volunteers, are clearly and comprehensively informed in advance about the associated health risk and as much as possible, are trained in the actions that might be required.

After termination of the emergency, the Station Manager has to establish a Recovery Organization. If significant in-plant radiological hazards exist (beyond those experienced during normal operation), the following activities have to be considered:

- performing extensive surveys of affected plant areas (radiation, contamination and airborne levels);
- radioactive waste processing, using supplementary portable equipment (if abnormal quantities of radioactive waste are present).

Appendix 16.5 – Generic Criteria for Protective Actions and Other Response Actions to Reduce the Risk of Stochastic Effects

Dosimetrical value	***Dose***	***Protective actions and other response actions if the projected dose exceed Generic Criteria***
Total Effective dose (E)	*100 mSv in the first 7 days*	• *sheltering;* • *evacuation;* • *prevention of inadvertent ingestion;* • *restrictions on food and drinking water;* • *traffic control* • *restrictions on commodities;* • *contamination control;* • *decontamination;* • *registration;* • *reassurance of the public.*
Equivalent dose on thyroid (H thyroid)	*50 mSv in the first 7 days*	*Iodine thyroid blocking.* *This protective action is prescribed:* • *if exposure due to radioactive iodine is involved;* • *before or shortly after a release of radioactive iodine;* • *within only a short period before or after the intake of radioactive iodine.*

Appendix 16.6 – Operational Intervention Levels

<table>
<tr><th>Type of monitoring</th><th colspan="2">Operational Intervention Level (OIL)</th><th>Actions if OIL is exceeded</th></tr>
<tr><td rowspan="3">Ambiental dose rate to 1 meter above the ground</td><td colspan="2">OIL1_γ = 1000 μSv/h
(on the first day after exposure is starting)</td><td><u>Public</u> (on the first day after exposure is starting)
• Evacuation
<u>Site personnel</u>
• Evacuation</td></tr>
<tr><td rowspan="2">OIL2_γ</td><td>= 100 μSv/h (for the first 10 days after the reactor shutdown)</td><td rowspan="2"><u>Public</u> (days/ weeks after the exposure is starting)
• It is recommended to relocate the population living in the area.</td></tr>
<tr><td>= 25 μSv/h (after more than 10 days after the reactor shutdown)</td></tr>
<tr><td>Ambiental dose rate to 1 meter above the ground</td><td colspan="2">OIL3_γ = 1 μSv/h above background</td><td>Public
• Restriction of food, water and feed</td></tr>
<tr><td>Ambiental dose rate at 10 cm from the naked skin of the hands and face (this monitoring is done in area where the background is less than 0.5 μSv/h)</td><td colspan="2">OIL4_γ = 1 μSv/h above background</td><td><u>Public</u>
• <u>Decontamination</u>
• <u>Medical follow-up</u>
<u>Site personnel</u>
• <u>Decontamination</u>
• <u>Medical follow-up</u></td></tr>
</table>

Contamination at 2 cm from the naked skin of the hands and face (this monitoring is done in area where the background is less than 0.5 μSv/h)	*$OIL4_{\beta}$ = 1000 cps above background*	*Public* • *Decontamination* • *Medical follow-up* *Site personnel* • *Decontamination* • *Medical follow-up*
Specific activity of I-131 and Cs-137 in food, milk and drinking water samples	*OIL7 = 1000 Bq/kg of I-131 or 200 Bq/kg of Cs-137*	*Public* • *It is recommended to forbid the consumption, distribution and sale of the affected food, milk or drinking water.*
Ambiental dose rate in front of the thyroid (monitoring should be made in contact with the skin in the first week after ingestion / inhalation of radioiodine in a background less than 0.25 μSv/h)	*$OIL8_{\gamma}$ = 0.5 μSv/h above background*	*Public* • *Medical support* • *administration of KI pills (if not already given and only in the first week after the reactor shutdown).* *Site personnel* • *Medical support* • *administration of KI pills (if not already given and only in the first week after the reactor shutdown).*

Appendix 16.7 - Generic Criteria for Emergency Response Personnel

1. Reference levels for Emergency Response Personnel:
   E < 50 mSv

2. Reference levels for life saving actions:
   E < 500 mSv

3. Actions to avert a large collective dose:
   E < 100 mSv

In order to ensure an effective response to a radiological event, a good coordination between Cernavoda NPP actions and public authorities' actions is necessary. In this respect, periodic meetings are organized between Cernavoda NPP representatives and public authorities' representatives, in order to establish their specific responsibilities, the notification means, the content and format of the information to be exchanged during an emergency, the necessary agreements for the support which might be required by the plant, the organization of the periodic general emergency exercises.

During an emergency with off-site effects, the Cernavoda NPP Management Representatives will go to Cernavoda Town Hall and Constanta County Emergency Inspectorate, in order to ensure the interface between the OSECC and the public authorities coordination centres (Local Emergency Operation Centre and, respectively, County Emergency Operation Centre). Their main responsibility is to provide to off-site responders accurate and reliable technical information, in a timely manner.

The on-site emergency plan covers all the activities performed on the Cernavoda NPP site in case of an emergency in order to protect the station personnel. It also covers the initial actions that must be performed to protect the population in the first hours of an emergency, which may have an off-site impact. The responsibility for off-site emergency planning lies with the public authorities. NPP shares some of the off-site emergency responsibilities with the Public Authority, especially in the initial stage of an emergency with off-site implications.

The on-site and off-site emergency plans, included in the general intervention plan, describes in general terms the measures required to control and mitigate the accident and to protect the site personnel and the public in case of an emergency. The actions to be followed by responsible personnel (personnel designated to respond to specific emergency situations) in order to meet the objectives of the emergency plan, are described in details in the on-site and the off-site emergency procedures.

In Romania, besides the Cernavoda NPP influence area, there are another two nuclear risk areas (emergency planning zones):

- the influence area of Kozloduy NPP (the Bulgarian NPP situated at few km distance from the Romanian – Bulgarian border, in the southern part of Romania);
- the influence area of TRIGA Research Reactor in Pitesti – Mioveni.

For each nuclear risk area, there are county plans for intervention in case of nuclear accidents. County emergency plans for radiological accidents have been elaborated and have been approved by IGSU. A National Nuclear Emergencies Response Plan is in place and is periodically updated.

The plan describe the external organizations and their responsibilities during an incident at nuclear facilities, which may have an off-site impact. The plan also contain the description of the essential steps for off-site emergency response activation, the protective action levels, and the protective measures. The protective actions, and the organization in charge to implement these actions, are identified for each emergency planning zone. Also, the plan describe the recovery activities, the international assistance, the periodic exercises, and the updating and revision of plans. Emergency procedures are in place, at all levels, in order to perform the response functions declared in the intervention plan.

The county emergency plans for radiological accidents are considering different types of accidents involving radioactive sources and materials used in medical, industrial, research or education facilities which can occur in a county (radioactive materials transport accidents, as well as finding, misplacing or losing radioactive sources). These plans specify the way to obtain expertise and services in radiation protection field, at local level, in a timely manner. When the situation requires, CNCAN experts are dispatched to the place of the accident for radiological investigations. Arrangements are in place between CNCAN and IGSU, CNCAN and specialised Police Teams for intervention in case of an accidental event involving radioactive materials.

Arrangements have been made in the last years for general practitioners and emergency staff to be made aware of the medical symptoms of radiation exposure and of the appropriate notification procedures if a nuclear or radiological emergency are suspected.

The Polyclinic of Cernavoda and County Hospital in Constanta have been prepared to treat injured people, for the eventuality of a radiation event at Cernavoda NPP. At national level, there is established a place for initial treatment of overexposed people at the Emergency Hospital from Bucharest.

16.2.4. Public information

The On-site Radiation Emergency Plan of the operator and the Off-site Radiation Emergency Plans of the public authorities establish the arrangements, the resources and the interfaces required for informing the public in case of a nuclear emergency. Joint information centres, staffed by representatives of the nuclear facility and of the public authorities, are established at the local and national levels.

As stipulated by the On-site Emergency Plan of Cernavoda NPP, those emergencies with off-site effects are to be notified to the response organizations (Cernavoda Town Hall, Constanta County Emergency Situations Inspectorate, IGSU, CNCAN), including critical information about the plant status and protective action recommendations for the public.

Also, during an emergency, the link between the plant personnel and the public authorities is ensured through the Cernavoda NPP representatives at Local / County Emergency Situation Committees, as member of these committees. In this respect, Cernavoda NPP Public Relations Officers will go to Cernavoda Town Hall / Constanta County Emergency Inspectorate, to ensure accurate and reliable technical information, in a timely manner, for the mass-media, by means of:

- informing the press agencies of emergency conditions and emergency response activities;
- developing methods to monitor broadcasts, bulletins and reports for misinformation; to respond quickly to public and media inquiries; and to rapidly respond to rumours or misinformation;
- providing in advance and ongoing information to the media and public on subjects that would be discussed during an emergency, such as radiation, nuclear plant operation and the on-site emergency plan.

CNSSU, at national level, and the County Committees for Emergencies, at local level, are responsible to give instructions and information to the public. The local and national TV and mass-media are used to keep the public informed about the accidental / radiological event.

Both CNCAN and the operator have the responsibility to support the public authorities in informing the public with accurate, timely and comprehensive information regarding the emergency, through their representatives at national level, in CNSSU, and at local level, in the County Committees for Emergencies.

At national level, the information includes aspects regarding the status of the nuclear / radiological facility and the status of planning / implementing the protective actions for population. At local level, the information includes also instructions and warnings for the population in the affected area.

Arrangements are in place in all nuclear risk areas in the country for prompt warning and instruction of population in the emergency planning zones, in case of an accidental event. The public in the vicinity of Cernavoda NPP and Kozloduy NPP has received printed information about the threat and how to behave in the case of an emergency. At local / county level, a Public Information Group is established in case of emergency in order to provide information to mass-media and population.

16.3. Training and Exercises

According to the regulations, all the response organizations must organize exercises, train the personnel and maintain an adequate level of training and all the necessary resources for an efficient response. The response authorities must have sufficient personnel, adequately qualified and trained for performing the actions provided by the intervention plan. At all levels of planning, the intervention plans must establish the types, frequencies and evaluation methods of exercises and drills, as well as the training necessity of the response personnel.

Furthermore, the licensee shall ensure the adequate initial and periodical training for the personnel authorized to declare emergency situations and to manage the intervention, personnel responsible for the evaluations necessary to be performed in emergency situations, teams assigned for radiological monitoring and decontamination, control room and field operators, fire fighting teams, repair teams and those assignees for evaluation of damages, rescue and first-aid teams. The personnel assigned for emergency response shall be regularly trained, at least every three months.

The licensee has to maintain and verify the training of its own personnel by organizing annual exercises. The exercise shall be planned such that they cover all the seasons and all meteorological conditions. All the exercises shall be followed by a critical evaluation in which will participate also representatives of the competent authorities. Also, the licensee has to participate in all the exercises organized by the public authorities, for the verification of the general intervention plan.

In this respect, Cernavoda NPP has implemented a Training, qualification and requalification program in emergency response for Cernavoda NPP personnel. Also, a systematic program of exercises is established. The exercises carried out at Cernavoda NPP are of the following types:

- Quarterly Emergency Drills, dedicated to train one or more components of the On-site Emergency Organization, are organized quarterly with each operation shift crew and annually with each emergency management and support shift crew;

- Annual Emergency Exercises, dedicated to test almost all areas of the Cernavoda NPP emergency plan, are organized during the normal work program, with each operation shift crew and emergency management and support shift crew, through rotation; these exercises are witnessed by CNCAN and the other public authorities involved in the off-site intervention;
- Full-scale Exercises simulate an emergency which results in radioactive releases outside the station and which requires the intervention of county and / or national public authorities; they are organized in collaboration with the public authorities, involving the neighbouring population, besides station personnel and public authorities personnel, at least once in three/four years and they have various scenarios in order to verify and test different parts of the emergency plan; they start at different hours of day and night, under various meteorological conditions and are scheduled to involve each operation shift crew / emergency management and support shift crew, through rotation, as much as practical;
- Exercises with external resources, carried out to ensure the harmonization of the site personnel response with the external resources which are taken into account in the emergency plan; because the On-site Emergency Plan establishes the firefighters support in the fire intervention actions, annually is organized a fire drill involving the firefighters, with the general objectives of familiarizing firefighters with the plant layout and of testing the cooperation between the Private Firefighters Services of the plant and the Professional Firefighters Units.

The objectives of these drills/exercises are planned for every 3 years and are established so that the On-site Emergency Organization personnel, in a 3-year period, is trained for all type of emergencies.

The exercises end with an analysis and a balance of activities in order to evaluate the ability of the various components / organizations involved. The deficiencies noted during the exercises that indicate a lack of skills or knowledge will be corrected with appropriate training.

As regarding the number of Cernavoda NPP personnel involved in emergency response, in case of alerts, the response activities are directed and coordinated from the Main Control Room (MCR) – Intervention Support Centre and they are performed by the shift personnel. There is a sufficient number of qualified personnel in each shift, able to perform response activities until the emergency organization is augmented, if necessary. The minimum shift complement ensures the number of trained personnel who are necessary for initial response actions. This complement will be augmented by shift civil fire fighters, shift security personnel, shift personnel in training, day personnel.

In case of emergencies which do need the OSECC to be set up, the Shift Supervisor will notify the emergency management and support personnel and will accomplish the Emergency Manager’s duties, till the authorized person will take over them. At least 5 persons from day personnel are appointed and trained for every emergency management and support position of the On-site emergency organization. In order to ensure the continuity of the human resources in case of emergency, the appointed persons are scheduled, both during normal working hours and after normal working hours (on-call).

Also, in this respect, arrangements are in place for the selection and training of personnel in all the organizations of the CNSSU. Important training courses and exercises, both national and international were conducted in the last years in the field of radiation emergency preparedness and response. The effectiveness of the response is tested and enhanced through carrying out periodical radiation emergency exercises for all areas and facilities. Once in a few years, all the responsible organizations participate in the national large scale exercises organized by IGSU. The frequency of the training and exercises became constant in the last 3 – 4 years, with at least one major international exercise and one major national exercise being organized by CNCAN in partnership with national and international institutions. The exercises are followed by an evaluation report, in order to assess the capability of the various response organizations to fulfil their attributions and to recommend measures for improving the response.

16.4. International Arrangements

According to art. 35 of the Law, one of the main attributions of CNCAN is to control the implementation of the provisions of international treaties and bilateral agreements on the intervention in case of nuclear accident, such as:

- IAEA Convention on Early Notification of a Nuclear Accident;
- IAEA Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency;
- Convention Regarding the Liability for Nuclear Damages;
- Bilateral Agreements on Early Notification of Nuclear Accidents and Exchange of Information on Nuclear Installations with Bulgaria, Greece, Hungary, Slovakia, Russian Federation and Ukraine.

In this respect, CNCAN is the national contact point as per IAEA Conventions for Early Notification and Assistance (according to IAEA letter EPR/CP(0100) from 16/11/2000), with the following functions (as defined in ENATOM, 2000):

- National Warning Point;
- National Competent Authority for Domestic Accidents;
- National Competent Authority for Accidents Abroad.

16.5. Summary of significant developments for the last reporting period

The most significant developments for the last reporting period are presented as follows:

CNCAN has revised and updated the regulatory requirements on emergency preparedness and response, in accordance with the international standards and European directives.

Cernavoda NPP has revised the On-site Emergency Plan, in order to:

- define the emergency planning zones and distances in accordance with IAEA standards;
- introduce information about resources needed to support the on-site emergency response during the first 72 hours of an emergency;
- introduce information regarding the emergency equipment and facilities provided by Cernavoda NPP to support the off-site emergency response;
- introduce events that affect the both units on the site;
- update protective actions if the projected dose exceeds the generic criteria.

In March 2017, Cernavoda NPP has finalized setting up the Intervention Support Centre at the Simulator, similar with those existing in each MCR from Units 1 and 2. The main purpose of this facility is to move the exercises from MCRs in the Simulator and to connect the Simulator with the On-site and Off-site ECC, this allowing for the possibility to carry on the simulator training along with the emergency drills/exercises.

Progress has been made in the construction of the new seismically qualified location for the on-site emergency control centre and the fire fighters, a measure taken as part of the National Action Plan post-Fukushima. The new location will include important intervention equipment (mobile DGs, mobile diesel engine pumps, fire-fighter engines, radiological emergency vehicles, heavy equipment to unblock roads, etc.) and will be protected against all external hazards. This action is currently estimated to be completed by the end of 2020. The delays in implementation have been due mainly to legal and administrative issues related to transfer of property of the physical location. Until the completion of this action, equivalent measures have been implemented to ensure that all intervention equipment (mobile Diesels, Diesel fire pump, fire trucks, and so) are protected from external hazards (e.g. the equipment have been relocated so that they would not be impaired by external events).

The emergency exercises carried out in the last three years at Cernavoda NPP include:

- 2016 - “VALAHIA 2016” Full-scale emergency exercise, 4 to 6th of October – Unit2, with the scenario involving a Large LOCA followed by earthquake causing SBO, which subsequently progressed to severe accident conditions.
- 2017 - “TOMIS 2017” Annual Radiological Emergency Exercise “, November 27, at Unit 1;
- 2018 - “UNIREA 2018” Annual Radiological Emergency Exercise, June 11.

Cernavoda NPP also implemented the following improvements in the area of emergency preparedness and response:

- Development of a software application for dose assessment for the intervention team members in case of severe accident;
- Supplemented the communication groups by the TETRA radio stations with a dedicated group for the monitoring teams;
- Concluded a contract for psychological counseling and psychotherapy services in case of emergency in order to provide psychological support to the intervention team members;
- Voice recorders in the On-site Emergency Control Center and the Off-site Emergency Control Center are in process of being procured, in order to record phone calls and verbal communication made during the emergency situations;
- Structural improvements to the On-site Emergency Control Center and the Off-site Emergency Control Center have been performed;
- The Diesel Generator for the fridge and cooking equipment in the canteen in the plant Campus is in process of being procured, in order to provide an auxiliary electrical power supply in the emergency food storage area.

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.

17.1 Regulatory requirements and licensing process for the siting phase

The general aspects regarding the regulatory framework and the licensing process have been provided under Article 7. This section gives details specific to the licensing process for the siting phase.

The licensing process and the general criteria for siting have been set, until the end of 2010, by the provisions of the Romanian regulation Nuclear Safety Requirements (NSR) - Nuclear Reactors and Nuclear Power Plants, which was in force since 1975 and which was based on the regulatory requirements of US NRC (10 CFR 100.11, 50.34 and Appendix A to Part 50).

The revision of the NSR regulation has started in 2009, taking account of the latest developments in international standards and guides on siting, with the purpose of providing a formalized set of criteria to be used in the selection of new sites and also in the periodic re-evaluations of all the site-related factors in the framework of the PSRs. The new regulation, Nuclear Safety Requirements on Siting of Nuclear Power Plants – NSN-01 has been formally issued at the end of 2010. In 2019, the Regulation on the Licensing of Nuclear Installations was issued, covering the licensing process for all the phases, with administrative and general nuclear safety requirements, without providing additional technical requirements and criteria for any specific licensing phase.

The requirements on the quality assurance for site evaluation and selection activities are formalized in the regulation NMC-03 (Specific requirements for the quality management systems applied to the evaluation and selection of the sites for nuclear installations). The regulation NMC-03 contains provisions for the different stages of the siting process, including the examination and assessment of various potential sites, the confirmation of the chosen location and the arrangements for site monitoring for the lifetime of the nuclear installation.

The licensing documentation for the siting of Cernavoda NPP has been prepared in accordance with the provisions of the NSR regulation. The documentation substantiating the safety demonstration for site acceptance is constituted by the Initial Safety Analysis Report (ISAR), together with the supporting technical studies and evaluations. The ISAR provides adequate justification for the site selection and summarises the assessments performed to ensure that the site characteristics are suitable for the design, construction, commissioning and operation of the facility. Although the emphasis of the report is on the identification and investigation of those site characteristics, which bear on safety, the report must also contain sufficient information on the conceptual design and operation of the nuclear installation. The preliminary evaluations of the impact on the environment are also included in the ISAR.

The site license for Cernavoda NPP (intended for five units) has been granted in 1979 by CSEN (see Article 7 for information on the development of the nuclear regulatory authority in Romania). The safety documentation for demonstrating the fulfilment of regulatory requirements and criteria comprised of the Initial Safety Analysis Report (ISAR) and the supporting technical studies and evaluations.

The factors taken into account in the evaluation of the site from the nuclear safety point of view included both those related to the characteristics of nuclear reactor design and those related to the specific site characteristics. In accordance with the regulatory requirements, comprehensive safety assessments have been performed to demonstrate that the reactor design ensures a very low probability for accidents resulting in significant radioactive releases and that the site choice and the technical measures taken to mitigate the consequences of the accidents, should these occur, ensure adequate protection of the public and environment.

17.2 Safety assessment of site related factors

The data collected during the examination, assessment and confirmation of site belong to the following categories:

a) data on the current and historical status of the site, resulting from censuses, geological, hydrological, meteorological and seismic data, records of examinations and other similar sources;
b) data regarding indirect explorations, resulting from direct or calculated information, from the collection of data, from testing and investigations performed in other purposes;
c) data from direct explorations, obtained from sampling, direct examination or from site tests;
d) laboratory tests.

The collection of data on site characteristics continued throughout the construction and operation phases, to verify the information obtained before the construction stage and to update it as necessary, to provide reassurance with regard to the adequacy safety margins.

The assessments performed (initial and updated) for the site-related factors are provided in the technical evaluations and studies referenced in the ISAR, PSAR (Preliminary Safety Analysis Report) and FSAR (Final Safety Analysis Report) respectively. These evaluations and studies have been performed in accordance with the national regulations and the recommendations in the IAEA Safety Guides, the US NRC Regulatory Guides, applicable international standards, etc. Their results are summarized in Chapter 2 of the FSAR for Cernavoda NPP, which contains also a detailed description of the site characteristics including:

- Geography and demography: description and localization of the site, exclusion zone control, population distribution on a 30 km radius area, density of population in the ring area between 30 and 100 km radius, transitory population, populated centres;

- Industrial facilities, transport routes and military facilities in the area: industrial facilities and activities, premises of economical and industrial development, railroad transport network and traffic characteristics, statistics of railroad accidents on a five year period, road traffic, dangerous goods transports in the area, naval transport, technical characteristics of the Danube-Black Sea Canal, winter phenomena on the Danube and Cernavoda area, perspective of naval traffic development until 2030, civil aircraft traffic, airport aircraft crashes and flight corridors, military facilities in the area, potential accidents caused by human and industrial activities in the area including explosions, toxic gas releases, gas and oil mains explosions;
- Meteorology: regional and general climatologic conditions, local meteorology, normal and extreme values of meteorological parameters, air circulation, atmospheric stability, meteorological phenomena, potential influence of the plant on the local climate;
- Hydrology: surface and underground waters, plant siting relative to water sources, Danube river, Danube-Black Sea Canal, flooding scenarios;
- Geology and seismology: regional geology, geotectonic structure of the site, hydro geological conditions, correlation between geological structure, tectonic movement and seismic activity, seismic faults in the area, maximum observed earthquake and maximum possible earthquake, site seismic characteristics, seismic hazard assessment input data and models, seismic design data confirmation.

The human induced hazards have been evaluated by using conservative analysis methods of the actual and estimated data (for 2010-2040 prognosis period) on industrial facilities and activities, naval, terrestrial and air transports, as well as military facilities and activities. For these categories of activities, there are evaluated potential accidents (explosions, toxic substances emissions, fires, missiles generation) occurring at industrial facilities around Cernavoda NPP (30 km radius), postulated explosions on terrestrial and naval transport routes in the vicinity of the plant, potential accidents due to air transports in the surrounding area (more than 30 km from the NPP), potential accidents due to military activities around Cernavoda NPP site.

As regards to the demographic data, the study on the distribution and density of the population in the influence area of the plant is generally updated for the revision of the Final Safety Assessment Report, as required by CNCAN for the renewal of the operating license.

The site area has been also evaluated with regard to ease of access for resources in the event of contingency and emergency response evacuation, availability and adequacy of off-site services (reliability of the grid), etc.

The applicable natural external events analyzed include earthquakes, surface faulting, meteorological events (including severe weather conditions), lightning, flooding (due to precipitation, dam bursts, etc.), slope instability, behaviour of foundation materials, etc. A systematic reassessment of the site-related factors was performed in the framework of the first Periodic Safety Review for Cernavoda NPP. Screening of occurrences related to site characteristics indicated the need for a systematic update of the safety case, with special attention to the assessment against the original design bases. Some issues arising from the review of the present site safety case against current safety guides and standards were also identified, such as climatic changes and biotic considerations in the safety case. As a follow up of actions raised from PSR, Cernavoda NPP prepared and delivered to CNCAN an

Action Plan. According to this plan, Cernavoda NPP contracted an external company to update the systematic review of external events. Up to date, the following analyses were elaborated: “External Hazards Systematic Analysis for CNE Cernavoda Site - Methodology”, “External Hazards Systematic Analysis for CNE Cernavoda Site – Hazards #8 (Natural Electro-Magnetic Interference), #9 (Cosmic Rays /Particles Bombardment) and #22 (Meteorite/Satellite Falls)”, following that the other external hazards to be re-assessed in future.

The licensee has re-evaluated the seismic safety of Cernavoda NPP in the framework of the project for developing probabilistic safety assessments. As a first step, the seismic re-evaluation of the site has been performed, using Probabilistic Seismic Hazard Analysis (PSHA) as the preferred methodology. The results of the Hazard Analysis have been used as input to the seismic PSA for the plant. The seismicity of the site and surrounding 300 km area was reassessed with state of the art methodology, seismic hazard study confirming the design data. Assistance from IAEA has been received in the development and the review of the PSHA and seismic PSA of the plant. The PSHA done for Cernavoda NPP confirmed the design provisions for qualification of the plant to a seismic event (design basis earthquake).

The latest studies of the site-related factors relevant to safety are reflected in the current Final Safety Analysis Reports (FSAR) and in the reports on the re-assessments performed after the Fukushima Daiichi accident ("stress test" reports).

17.3 Safety reviews and assessments performed post-Fukushima

After the Fukushima Daiichi accident, a complex safety review of the protection of Cernavoda NPP against external events was undertaken in the context of the European "stress tests". More information has been provided in the Romanian National Report for the 2nd Extraordinary Meeting under the Convention on Nuclear Safety, which is publicly available.
(http://www.cncan.ro/assets/Informatii-Publice/06-Rapoarte/RO-National-Report-for-2nd-Extraordinary-Meeting-under-CNS-May2012-doc.pdf)

A summary of the results of the re-assessment of Cernavoda NPP protection against external events is provided as follows.

Protection against earthquakes

A seismic margin assessment was performed for Cernavoda NPP, with a review level earthquake (RLE) established at a reasonably high level seismic ground motion, based on site seismicity and plant specific design features. The seismic margin assessment shows that in comparison with the original design basis earthquake of 0.2g, which has a frequency of 1E-3 events/year, all SSCs which are part of the safe shutdown path after an earthquake would continue to perform their safety function up to 0.4g, which has an estimated frequency of 5E-5 events/year. This margin is considered adequate as it meets the safety goals applied internationally for new NPPs.

Based on deterministic studies performed by national institutes for earth physics, seismic events yielding a PGA > 0.2g are considered physically not possible. Based on the seismic margin assessment performed, there are no cliff-edge effects occurring for PGA ≤ 0.4g. Additional margins exist beyond the value of 0.4g, but they have not been quantified.

The potential of Cernavoda NPP units flooding induced by an earthquake exceeding the DBE has been analyzed by considering all the failure mechanisms consisting of failure of dams and other hydrological or civil structures collapsing and the tsunamigenic potential of a Black Sea originating earthquake. The results of these analyses show that the effect of these failure mechanisms has physically no potential for seismically induced flooding of the Cernavoda site.

The potential for seismic induced internal plant flooding was also analyzed and it was concluded that this does not pose a threat to the equipment qualified to perform the essential safety functions after an earthquake. As for the potential for earthquake-induced internal fires, the inspections conducted post-Fukushima confirmed the design robustness and good material condition regarding the fire protection.

The seismic walk-downs and subsequent seismic robustness analyses done as part of the seismic margin assessment have not revealed a need for any safety significant design change. However, several recommendations resulted from these inspections, such as increasing the seismic robustness of the batteries, have been implemented by the licensee as part of the regular plant seismic housekeeping program.

Protection against external flooding

Based on the analysis results obtained by making use of the latest deterministic tools and complemented by probabilistic approach, it was concluded that the Cernavoda NPP design intent in relation with flooding hazards provides sufficient safety margins, therefore no further measures for improvement were envisaged in this area. However, following a generic recommendation from a "stress test" peer review, concerning the improvement of volumetric protection of the buildings containing safety related equipment located in rooms below plant platform level (so that protection does not rely solely on the elevation of the platforms), potential measures have been identified and design modifications were approved and implemented to replace selected doors with flood resistant doors and penetrations sealing. Sand bags have also been made available on site to be used as temporary flood barriers, if required.

Currently, improvement initiatives for volumetric protection are done (replacement of selected access doors with flood resistant doors and room penetrations sealing of several areas were safety related equipment are located underground), in addition to the passive protection measure ensured by the plant platform elevation.

Based on review of the enhanced design provisions and operating procedures, the plant strategy in response to internal and external flooding events was revised and required modifications of plant procedures performed. Flood protected areas are periodically inspected as per dedicated plant routines.

Protection against extreme weather events

Based on the assessment performed, the licensee concluded that adequate safety margins exist in relation to extreme weather conditions, taking account margins provided in the design of the safety related SSCs as well as the time available for preventative measures in slow developing scenarios.

For cases in which the extreme weather conditions could affect the availability of the off-site power supply and / or the transfer of heat to the ultimate heat sink, based on the review of severe weather conditions and their impact on the plant, it was concluded that these would not generate worst accident scenarios as compared with SBO (Station Black-Out), LOUHS (Loss of Ultimate Heat Sink) and SBO + LOUHS events.

The examination of extreme weather events consistently performed with international practice revealed that none of the external events related to severe weather has the potential to induce accident sequences not covered by the existing safety analysis, plant operating documentation or response capacity of the Cernavoda NPP. Nevertheless, the specific procedure for responding to extreme weather conditions has been revised to include more proactive actions.

Regulatory reviews

CNCAN has reviewed the methodology used for the assessment of external events and the results and has acknowledged that these reflect the current standards and good practices and state-of-the-art knowledge. The "stress test" peer-review for Romania acknowledged the comprehensive studies and work performed to increase protection of the Cernavoda plant against seismic events and the substantial and recent studies for the assessment of flooding hazards.

The peer-review report for Romania recommended that CNCAN further investigates safety margins to cliff-edge effects for extreme external events. This is a generic issue and further studies will be required and performed once a common methodology is developed and agreed upon at international level.

17.4 Evaluation of the impact on the population and the environment

As required by the legislation on environmental protection, a detailed assessment of the impact of the installation on the environment has to be prepared by the applicant, and submitted to the governmental and local environmental agencies for their review. The environmental agreement issued by the central authority for environmental protection has to be obtained prior to the issuance of the siting license, or of the construction license (for the case in which a unit is built on an already licensed site) granted by the nuclear regulatory authority. The environmental authorization is issued by the central authority for environmental protection (the Ministry of Environment) after the issuance of the operation license by CNCAN.

For Units 3 and 4 of Cernavoda NPP, the actions required by the procedure established by the Ministry of Environment for issuing the environmental agreement have been initiated in 2006. During this process, the report on the environmental impact assessment was completed, including aspects related to thermal impact of discharge water and biodiversity protection. The environmental agreement procedure included national public consultations as well as transboundary consultations (under ESPOO Convention auspices) on the environmental impact assessment report. The environmental agreement for Units 3 and 4 was issued by the Governmental Decision no. 737/2013.

During the preoperational stage, the licensee is responsible to monitor the distribution and the characteristics of the population around the installation, its occupations and habits, food consumption rates and origins of consumed food, ways to spend the time, as well as agricultural and aquatic characteristics (species, agricultural practices, gardening activities, etc.). All these data have to be periodically verified during the operational stage of the plant. Also, the use of the river water must be monitored in the vicinity of the plant and as far downstream as might be subject to significant contamination.

In accordance with CNCAN requirements on the monitoring of the radioactive discharges into the environment, the licensee is responsible for supplementing the environmental radioactivity monitoring program with support studies, dedicated to other types of measurements and/or activities of collecting general data about the environment and population characteristics. In this respect, the licensee is responsible to ensure, not only during the preoperational stage, but also for the entire period of operating the plant, the monitoring of climate conditions and hydrological characteristics of the rivers receiving the liquid effluents (according to the CNCAN requirements on meteorological and hydrological measurements for nuclear installations).

The general objective of the above mentioned support studies is to detect the occurrence of important changes of the environment, which may significantly affect the radionuclides transfer into the environment and thus the exposure pathways. In such cases, the licensee shall reassess and accordingly modify the environmental radioactivity monitoring program, and submit it for approval by CNCAN.

Starting with 1984, Cernavoda NPP deployed a preoperational monitoring program, which was contracted by two Romanian Nuclear Research Institutes (IFIN Magurele and ICN Pitesti). The sampling points were established taking into consideration the distances from the future NPP effluents discharging points, the predominant wind direction, the presence of the population and its food consumption habits. The procedures for sampling, sample preparations and measurements were established and agreed by the two contractors. Generally, samples of air, surface, drinking and ground water, soil, sediment, spontaneous and cultivated vegetation, as well as food and feed were quarterly collected and analyzed for their radioactive content by total alpha and beta measurements, gamma spectrometry, tritium, uranium and Sr-90 determination. The results were reported to the NPP quarterly and annually.

The measurements made under the preoperational program detected the environmental radioactivity changes resulted following the Chernobyl accident in 1986; starting with 1990, the radioactive concentrations in the majority of the environmental media returned to the normal values, registered before 1986, excepting the Cs-137 in soil and sediment which is still present in some points, in low concentrations, showing a decreasing tendency. The results of this program are used as reference values in the estimation of the impact of Cernavoda NPP operation on the surrounding environment.

Cernavoda NPP operates a meteorological tower, 80 m high, located at approx. 1.5 km from the plant and equipped with sensors placed at 3 levels (10 m, 30 m and 80 m). The meteorological data (air temperature, wind direction and speed, precipitations) are automatically sent to the MCR and SCA at 10 minutes intervals; in 2004, the system was updated by changing the sensors, modifying the software and setting up a new monitoring point.

Starting with 2002, Cernavoda NPP contracted, besides the meteorological prognosis services, monthly diagnosis services provided by Constanta Regional Meteorological Centre of the National Administration for Meteorology. The data provided through this contract are in good agreement with the data provided by the onsite meteorological tower, even if there are differences between the two locations (in terms of level, data collecting techniques, physical distance between them of about 2 km).

The hydrological data (level and temperature, daily flows, monthly upstream/downstream temperature gradient) of the Danube river are provided for Cernavoda NPP on a contractual base, by the National Company “Apele Romane”. All these data are reported annually by the plant, together with the environmental radioactivity data, as resulted from the monitoring program.

More information on the environmental radioactivity monitoring program is provided under Article 15.

17.5 Public Hearing Procedure

The procedure for obtaining a construction license for a nuclear installation includes the obligation to perform and submit an environmental impact assessment (EIA).

The neighbouring countries that could be affected by the installation are notified on the basis of the international Convention on Environmental Impact Assessment in a Transboundary Context (ESPOO Convention), to which Romania is a contracting party.

17.6 Significant developments for the last reporting period

In the last reporting period, a new Environment license has been issued by the Government of Romania, through the Ministry of Environment, for the operation of Cernavoda Units 1 and 2. The entire licensing process took more than two years and was based on the documentation submitted by the Cernavoda NPP which shown that all the environmental aspects at Cernavoda NPP are within the legal limits and followed the best practices in the industry. As part of the licensing process, a public hearing took place in Cernavoda area.

Also since 2018, Cernavoda NPP is registered EMAS (Eco-Management and Audit Scheme). EMAS represents a management instrument developed by European Commission for companies and other organizations to evaluate report and improve their environmental performance. Being EMAS registered gives confidence to any stakeholder that Cernavoda NPP is committed to improve the environmental performance. The preparation activities took more than 2 years, and the verification itself, held by an independent accreditation body, took one year.

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 (defence 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.

18.1 General description of the licensing process for the design and construction phases

The general aspects regarding the regulatory framework and the licensing process have been provided under Article 7. This section gives details specific to the licensing process for the construction phase.

The main regulatory requirements on the licensing process for the design and construction phases are provided in the regulation NSN-02 - Nuclear safety requirements on the design and construction of NPPs (2010) and in the NSN-22 - Regulation on the licensing process for Nuclear Installations (2019).

As a first step in the licensing process for the construction of a new unit (provided that the site license had been issued, as it is the case for Cernavoda NPP), a Licensing Basis Document (LBD) is submitted for approval to CNCAN. The LBD includes all applicable regulatory documents (including those established by other authorities than CNCAN), codes and standards, safety design requirements, the list of all the design basis events, safety analysis requirements, and the general requirements for the stages of construction, commissioning and operation. The applicable international safety standards and guides are also endorsed by means of the LBD.

The LBD is reviewed by CNCAN, which imposes changes and/or additional requirements, as the case may be. Once approved, the LBD becomes the main document based on which the license applicant establishes arrangements for the work to be performed in the preparation of the Preliminary Safety Analysis Report (PSAR).

The PSAR constitutes the main document submitted by the applicant to CNCAN for review and approval for obtaining the Construction License. The PSAR includes, as a minimum, the following information:

- Description of the site and of the site-related safety factors;
- Analysis of the compliance with the safety requirements for the main systems of the installation at the nominal design values of operation;
- Presentation of any new or unusual design solutions used and evaluation of their impact on the safety;
- Preliminary data and solutions adopted in the design, construction, commissioning and operation of the nuclear installation so that to ensure compliance with the general design requirements in the national nuclear safety regulations;
- Preliminary safety evaluation of the plant systems to confirm that they assure an acceptable safety margin during normal operation, transients and accidents and the

existence of the adequate technical and administrative measures to cope with postulated events, including severe accidents;
- Description of the technical limits and conditions;
- Description of the organization in charge of construction and the measures taken to comply with the nuclear safety requirements;
- Description of the quality assurance program;
- Identification of the systems, components, design solutions, etc. which need a special research program to be completed prior to operation in order to demonstrate the full compliance of the installation with the safety requirements.
- Description of the emergency plan to be implemented up to operation.

The PSAR, SDGs (Safety Design Guides), DMs (Design Manuals) and any other documents referenced in the PSAR and later on in the Final Safety Analysis Report (FSAR), such as technical evaluations and studies, safety analyses, procedures, commissioning reports, drawings, etc., constitute the documentation that substantiates the safety demonstration for the operation of the plant.

The main licensing milestones during the construction phase for a CANDU unit include the reception and storage of the heavy water, the reception and storage of the nuclear fuel and the heavy water loading into moderator system. After these are completed and compliance with all the applicable requirements is demonstrated, the application for the commissioning license is submitted to CNCAN. The complete list of licensing milestones is given under Article 19.

The regulatory oversight during the construction stage consists of audits, inspections and periodic licensing meetings, with the most comprehensive assessments and inspections performed on the occasion of the licensing milestones. For each of the licensing milestones a formal approval/authorization is granted by CNCAN to the licensee to further proceed with the work, provided that all the specific requirements and conditions have been fulfilled. For example, prior to granting the approval for heavy water loading into the moderator system, one of the conditions for the licensee is to demonstrate that all construction activities related to the plant systems needed for that milestone are completed, that the necessary verifications and tests have been performed with acceptable results and also that all the required documentation is available and adequate.

During the construction phase, the main process used by the licensee to confirm that the structures and systems are installed and completed as per design is the Construction Completion Assurance (Construction CA). The Construction CA process encompasses all the assessment and verification activities necessary to provide reassurance that the as-built plant fulfils all the design requirements, as well as all the requirements deriving from the applicable regulations, codes and standards on nuclear safety and quality assurance.

The independent verification of the work performed during construction and of the construction completion status is done by the commissioning personnel, in the process of turnover from construction to commissioning, in which the responsibility is transferred from the Construction organization to the Commissioning organization. This turnover process is done by systems or groups of systems. A controlled process is in place to manage incomplete items. All the Construction Managers are responsible for the turnover process in their discipline and for preparing the respective Construction CA Statements and submitting them to the Construction General Manager, who is in charge of preparing the Overall

Construction Completion Certificate. This Certificate is forwarded to the license holder for review and endorsement. The Construction Completion Certificate, approved by the legal representative of the license holder, is submitted to CNCAN as part of the application for Fuel Load, which is the first licensing milestone after the commissioning start.

18.2 Safety Philosophy and Defense in Depth

The safety philosophy of CANDU reactors, based upon the principle of defense-in-depth, employs redundancy (using at least two components or systems for a given function), diversity (using two physically or functionally different means for a given function), separation (using barriers and/or distance to separate components or systems for a given function), and protection (seismically and environmentally qualifying all safety systems, equipment, and structures).

An important aspect of implementing defense-in-depth in the NPP design is the provision of a series of physical barriers to confine radioactive material at specified locations. In CANDU design these barriers are the fuel matrix, the fuel sheath (clad), the Heat Transport System (HTS), and the Containment. An additional administrative barrier is the exclusion area boundary.

For design purposes, the safety related systems and structures have been defined as those which, by virtue of failure to perform the safety functions in accordance with the design intent, could cause the regulatory dose limits for the plant to be exceeded, in the absence of mitigating system action.

The safety related systems and structures of a CANDU NPP can be broadly categorized as follows:

- Preventative: Systems and structures that perform safety functions during the normal operation of the plant, to ensure that radioactive materials remain within their normal boundaries. These are systems and structures whose failure could cause a release exceeding the regulatory dose limits during normal plant operation, in the absence of further mitigating actions, or whose failure as a consequence of an event could impair the safety functions of other safety related systems.
- Protective: systems and structures that perform safety functions to mitigate events caused by failure of the normally operating systems or by naturally occurring phenomena.

Some systems may perform both protective and preventative safety functions, and therefore may have more than one safety category designation.

The protective systems defined above are further identified as:

- Special Safety Systems, which include Shutdown System No. 1, Shutdown System No. 2, Emergency Core Cooling, and Containment.
- Safety Support Systems, which provide essential services needed for proper operation of the Special Safety Systems (e.g., electrical power, cooling water). These systems may have normal process functions as well.

The Special Safety Systems are always in stand-by during the normal operation of the plant and ready to mitigate the consequences of any serious process failure. They are totally independent from the process systems.

The Special Safety Systems and stand-by safety related systems have been physically separated by their assignation into two groups (Group 1 and Group 2) in order to provide adequate protection against common cause failures from events such as:
i) Turbine disintegration and resultant missiles;
ii) Fires that can lead to uninhabitable control centre, wide spread system damage, etc.;
iii) Aircraft crash;
iv) Failure of a common process e.g. Electrical Power Systems, Service Water System, etc.;
v) Common adverse environment e.g. extremes of temperature, pressure, humidity, radiation, toxic gases, etc.

In addition, within each group, there is separation between each the Special Safety Systems and between the channels of a system. The separation is achieved by the physical arrangement of equipment and of protective channels.

The essential safety functions that can be performed by either Group 1 or Group 2 are:
- reactor shutdown;
- fuel cooling;
- confinement of radioactivity;
- providing the operators with the alarms and indications required to assess the state of the unit and to take the necessary actions to mitigate the consequences of an accident.

Each group includes one SDS and either the ECCS or the Containment, because the analyses of the most severe cases, as presented in the Safety Report, assume one SDS system is unavailable and that either the ECCS or Containment is unavailable. As it is not possible to suffer more than those unavailabilities, it follows that the safety of the facilities is ensured at all times. Component redundancy is built-in for the Special Safety Systems to ensure that the single failure criterion is satisfied. Special Safety Systems satisfy an unavailability target of 10^{-3} years/year, which effectively requires redundancy of all critical components.

The availability of these systems is verified during operation by regular safety system component tests. Specific requirements are applied to the triplicated instrument cables and the duplicated power and control cables for safety-related systems. The odd and even concept of on-site power distribution is applied to equipment, the raceway system and junction boxes, in order to maintain physical separation between the odd and even systems to achieve maximum reliability under normal and abnormal conditions

To satisfy reliability requirements to meet safety objectives, the Group 1 Electrical Power System is equipped with stand-by Diesel generators supplied with support services from Group 1 systems. The power distribution system is designed to prevent propagation of electrical faults to the Group 2 Emergency Power Supply System and vice-versa. The portions of the distribution system needed to supply electrical power from the Group 2 Emergency Power Supply System to components required for the earthquake events are seismically qualified.

For the purpose of safety assessment all major systems in CANDU reactors are categorized as “process systems” and “special safety systems”. All special safety systems are independent from all process systems and from each other.

The CANDU safety philosophy is based on the concept of single/dual failures. “Single failure” is a failure of any process system which is required for the normal operation of the plant and “dual failure” represents a combination of the single failure events and a simultaneous failure or impairment of one of the special safety systems. Coincident failure analysis is a systematic assessment of postulated dual failures.
Each postulated process failure is systematically coupled with a failure of one of the special safety systems. Loss of the shutdown systems is excluded from required dual failure sequences because the design includes two independent shutdown systems which are each capable of shutting down the reactor.

A distinguishing feature of dual failure assessment is that the analysis of CANDU 600 reactors must show that:

- coolable core geometry is retained, even if the ECCS were to be impaired;
- radioactive releases are adequately prevented, even if the containment system were to be impaired.

The deterministic analyses, including the description of initiating events, event sequences, acceptance criteria, methodology, results and interpretation are provided in Chapter 15 of the FSARs. Each of process systems failures (initiating events) considered were analyzed for the case in which the ECCS and the containment subsystems are available, and also in combination with various failures/impairments to either ECCS or containment subsystems.

Feedwater events and main steam line breaks were also analyzed in combination with loss of Class IV power. Large LOCA and small LOCA events are analyzed also in combination with loss of off-site power and with impairments to either ECCS or containment system functions.

CANDU-600 is a proven design and sufficient information is publicly available on the general design features and on the CANDU safety philosophy and approach to prevention, mitigation and management of accidents. Therefore, this section only gives some examples of CANDU design features relevant for each of the levels of the defense in depth.

Prevention

- The reactor coolant pressure boundary is designed in accordance with ASME Section III - Class 1 requirements, as supplemented by Canadian Standards in the areas not covered by the ASME Code. The pressure tubes of the PHTS have “leak-before-break” characteristics. The plant is provided with extensive and sensitive leak detection systems. The presence of tritium in the PHTS makes the leak detection very efficient even for very small leaks.
- The on-line tritium in water detection system is used for revealing leaks to heat exchangers and to the S/G tubes.
- PHTS leaks open to Reactor Building atmosphere are revealed by the increasing of D_2O vapours recovery or by balance of heavy water into PHTS.
- The probability of occurrence of a sudden large-size break in a pressure tube is extremely low, in view of the following considerations:

i) as per design, the tube-wall thickness was selected such that leakage will precede tube rupture (“leak-before-break” concept);
ii) a leak of a pressure tube can be detected quickly (by means of the surveillance system analyzing the gas contained in the annular space between pressure tubes and calandria tubes)

thus allowing ample time for corrective action;

iii) the pressure tubes and their end-fittings can be inspected by means of ultrasonic techniques, thus providing an up-to-date overview of the state of the pressure tubes;

iv) although the pressure tubes are designed to serve for the entire life time of the plant, they can be replaced with relative ease, thus permitting early elimination of tubes showing any signs of faults.

- On-power refueling implies that the power distribution reaches an equilibrium in less than a year from initial start-up, and remains virtually unchanged for the reactor's operating life. This greatly simplifies the analysis of core behaviour as a result of postulated accidents.
- CANDU fuel is highly reliable, being composed of natural uranium oxide. On-power refueling allows for defective fuel to be detected, localized and removed from the core, reducing the contamination of the reactor coolant piping and simplifying maintenance.
- There is no criticality hazard in the handling or storage of the UO_2 fresh/spent fuel because it is not enriched and cannot be arranged in a critical array, except for in heavy water.

Control

- CANDU NPPs are provided with extensive instrumentation and control systems, capable of monitoring those variables and systems that can affect the fission process, the integrity of the reactor core, the PHTS pressure boundary and the containment. Most control functions for the reactor and the Balance of Plant, including automatic start-up, are performed by two identical, independent digital computers, each capable of complete station control. The two computers run simultaneously, one acting as instantaneous back-up to the other. Protection functions are, however, not performed by the digital process control computers but by Programmable Digital Controllers (PDCs), there being strict separation between control and protection systems.
- The Reactor Regulation System (RRS) is part of the fully computerized control system. This computerized control system is also responsible for boiler pressure and level control, unit power regulation, primary heat-transport pressure and inventory, and turbine run-up.
- The design philosophy for the RRS is to limit the maximum rate of reactivity additions to a value low enough to achieve safe control in all conditions. The neutronic flux spatial control system is designed to maintain stable control of the power distribution for any of the normal movements of other control devices such as adjuster rods or liquid zone controllers. The reactivity change due to refueling is also adequately controlled by liquid zone controllers.
- The low excess reactivity of the CANDU core leads to relatively low reactivity worth of the control devices, limiting the potential severity of postulated loss-of-regulation accidents.
- Apart from the four systems employed by RRS, using control rods, adjuster rods, light water compartments and poison addition into the moderator region, two independent and diverse fast-shutdown systems are provided.
- Furthermore, the relatively open core lattice of the CANDU reactor permits complete separation between control and protection functions also for the neutron poison devices (i.e. the control rods used by RRS are the 4 mechanical control absorbers - MCA, while the SDS #1 uses 28 shutoff rods; poison addition to the moderator is done by RRS through the moderator liquid poison system, while the SDS #2 inserts poison from its own liquid injection shutdown units).
- To ensure that localized overrating of the fuel does not occur an array of self-

powered flux detectors is provided for application in the regional overpower protective (ROP) system. A separate array of detectors is provided for each of the two shutdown systems.

- The self-protection functions of the RRS (Stepback and Setback) are essential to ensure that station operation is within the boundaries assumed in the analyses. In the majority of event scenarios, the above mentioned self-protection functions can avoid reaching the trip set points of the Shutdown Systems (SDS#1 & SDS#2). The availability of the Reactor Regulating System (RRS) is absolutely required for maintaining the reactor in the critical state. Consequently, on a loss of RRS, the reactor is tripped immediately, with no attempt at re-start.
- Heavy-water neutron kinetics is slower by several orders of magnitude than light-water kinetics, this making the control easier because of the inherent kinetic behaviour of the delayed neutrons.
- Provision of passive heat sink after common mode events like loss of electrical power is ensured by thermosyphoning through the steam generators.
- The plant is provided with two separate control rooms in different locations, each with capability of shutting down and cooling the reactor to cold conditions, and providing continuous monitoring-of-the-plant information to the operating staff; this capability is still maintained in each control room even if total failure of all equipment in the other control room is assumed.

Protection

- The Safety Systems are fully automated, although they can be actuated also manually if required. Each system is independent of the others, employing its own sensors, logic, and actuators. Each system uses triplicated logic in two out of three logic configuration, (three sensor circuits, with two-out-of-three voting), with the ability to be tested on-line. Also, the fail-safe design principle has been implemented in the design of the Safety Systems.
- SDS#1 uses solid shutoff rods (stainless steel sheathed cadmium absorbers), dropping by gravity into the core, and is capable of shutting down the reactor for the entire spectrum of postulated initiating events. SDS#2 uses high-pressure liquid poison (gadolinium nitrate) injected into the (low-pressure) moderator, and is also capable of shutting down the reactor for the entire spectrum of postulated initiating events.
- Each SDS, acting alone, is capable of shutting down the reactor within less than 2 seconds and maintaining it subcritical under cold conditions, for all accident scenarios. In safety analysis, the two most effective of 28 shutoff units for SDS#1 are assumed unavailable. Likewise, one of six liquid poison injection nozzles for SDS#2 is assumed unavailable. Prompt criticality is not reached in accident conditions, as shown by analysis.
- The positive reactivity that would be introduced by loss of coolant accidents is well within the capability of mechanical and hydraulic shutdown systems.
- An important intrinsic safety feature of the CANDU reactor is that all neutron control devices are installed in the low-pressure moderator region, where, in case of a postulated LOCA due to a break in the headers or feeders, they are not subjected to potentially severe hydraulic forces. The moderator also provides a low-pressure environment for the control rods, eliminating the "rod-ejection" scenarios. In addition, the location of neutronics measurement devices in the moderator avoids subjecting this equipment to a hot, pressurized environment.
- Under any operating state, the CANDU 6 has a number of heat sinks. At full power, the main heat sink is provided by the four steam generators. The other heat sinks become more important when in a shutdown state or during abnormal events. This can be either

through the Shutdown Cooling System (SDCS), the Emergency Water Supply System (EWS), or the Boiler Make-up water system (BMW).

- The steam generators with the Feed Water System remove reactor heat during normal plant operation. The Auxiliary Feedwater System and/or the Shutdown Cooling System removes the decay heat during plant shutdown. These systems belong to Group 1, they are designed to remove normal and decay heat and are powered by the normal (Class III, II and I) electrical power systems.
- The Shutdown Cooling System (SDCS) is designed for the full nominal operating pressure and temperature of the PHTS, so it can, if needed, be connected to the PHTS immediately following reactor shutdown, precluding the need for depressurization after a loss of heat sink.
- Following a common mode event that may disable the above means of decay heat removal, a second independent means of decay heat removal is provided by the Emergency Water Supply (EWS) System which is powered independently by the Emergency Power Supply (EPS) System. Accordingly, the EWS and EPS Systems belong to Group 2.
- The EWS system has a function/feature known as the Boiler Makeup Water (BMW). This subsystem automatically feeds water under gravity to the secondary side of the boilers when they become depressurized following a loss of boiler feedwater. The source of BMW system is the water stored in the dousing tank.
- It should be noted that the Group 1 and Group 2 means of removing decay heat have the PHTS and the steam generators in common. Open path to atmosphere is ensured by Group 1 (ASDV) and Group 2 (MSSV) relief devices.
- The ECCS can maintain or re-establish core cooling by supplying coolant to all reactor headers. It consists of three phases: high-pressure water injection (used during the early stages of an event), medium pressure water supply from the containment building's dousing tank (used during the intermediate stages), and low-pressure water supply based on recovery from the building's sump. The ECCS is designed for LLOCA - 100% break of the largest pipe (reactor header). The discharge area is equal to twice the cross-sectional area of the pipe assumed to fail. Sensitivity analysis for the comparison of a 100% longitudinal break and a double ended guillotine break has shown very similar results, so longitudinal breaks have been modelled for all break sizes up to 100%.
- Considerations with regard to the ECCS:
  i) the simple configuration of the individual fuel channels facilitates coolant delivery to all core locations;
  ii) the correct performance of the ECCS does not constitute the final defense against core meltdown in case of LOCA; the accident analyses, supported by experiments, indicate that a LOCA combined with ECCS failure, though resulting in limited fuel damage (including partial melting of the cladding) and some deformation of the pressure and calandria tubes, does not result in fuel melting; the decay heat can be removed by conduction through the walls of the pressure and the calandria tubes into the moderator, and rejection by the moderator cooling system, which can remove than 4% of the total thermal power, enough to accept decay heat indefinitely.
- The Containment System forms a continuous, pressure-confining envelope around the reactor core and primary heat-transport system. In the CANDU 6 design it consists of a pre-stressed, post-tensioned concrete structure, an automatically-initiated dousing system, building coolers, automatic isolation system and a filtered air discharge system. The containment system prevents releases of radioactivity to the public in the event of failure of the nuclear components of the heat transport system. The design basis event considered is any LOCA event concurrent with dousing failure. This event presents the highest potential in terms of peak pressure. However, the events related to steam systems breaks are also

considered in terms of maintaining structural integrity of containment. The containment structure and all other parts of the containment boundary, are pressure and leakage tested before first criticality and leakage tested periodically thereafter. Another inherent safety characteristic of CANDU 6 plants is the low ratio of reactor thermal power to containment volume.

Mitigation

- The large-volume, low-pressure, low-temperature moderator surrounding the fuel channels acts as a heat sink in LLOCA + LOECC scenarios (which for CANDU are included in the design basis), rendering negligible the risk of fuel meltdown. The pressure tubes will sag and/or strain into contact with the calandria tube where further deformation will be arrested by the cooling of the moderator system.
- In a loss of heat sink or loss of flow event (such as a total station black-out), the reactor coolant will heat up and pressurize which can cause the pressure boundary to fail. In a CANDU reactor experiencing the same initiating event the fuel heat-up in the fuel channels will cause one of the many pressure tubes to rupture, depressurizing the system by blowdown into the moderator well before boiler tube might fail and before a high pressure melt ejection can occur. The pressure tubes act like fuses in this instance. Failure of one channel is sufficient to limit widespread channel failures because it results in rapid heat transport system depressurization and induced blow down cooling. Furthermore, heat transport system depressurization occurs well before potential formation of molten core conditions, thereby assuring that high pressure melt ejection does not exist as a containment challenge in CANDU reactors.
- A large volume of light water surrounds the calandria vessel in the calandria vault. Thus, the design ensures a passive heat sink capability which, in many event sequences, would provide significant time delays in the progression of the accident. The calandria vault provides the third line of defense (after the ECC and the moderator) in cooling the reactor core during a severe accident. The large volume of water in the calandria vault has adequate thermal capacity to passively prevent calandria vessel failure. Water in the calandria vault can provide continued external cooling of the core debris relocated at the bottom of the calandria. During this process, the significant volume of water inside calandria vault cools the outer calandria vessel wall, maintaining the external cooling of the vessel. As long as calandria vessel is mostly submerged in water and the calandria vault water inventory can be maintained, it is expected that corium will be retained in the calandria vessel and accident progression arrested in-vessel. The externally cooled calandria vessel acts as a “core catcher” containing the core debris. Core disassembly and relocation take place only at low heat transport system (PHT) pressures and that melting of core materials is avoided until after the debris has relocated to the bottom of the calandria vessel.
- Overall, high volumes of water in the Heat Transport System, in the calandria vessel and in the calandria vault, notwithstanding the water volume from the dousing tank, all ensure a CANDU-specific extensive heat sink capability that confers a slow progression of severe accidents
- Since the geometry of the CANDU core is near optimal from a reactivity standpoint, any rearrangement under severe accident conditions ensures shutdown. Therefore, re-criticality under is not a concern for a CANDU reactor.
- The bottom of the large calandria vessel provides a spreading and heat removal area for core debris following a severe core damage accident.

18.3 Specific consideration of human factors and man-machine interface

The reliable, stable and easily manageable operation of the CANDU reactors is facilitated by the use of a digital computer system, which offers many advantages over the human operator in terms of carrying out routine data handling, decision making and control functions.

Control Computer System functions are:
- Control/Monitoring;
- Alarm/Annunciation;
- Display/Data Recording.

Those functions for all the NSP side of the plant and part of the BOP side are accomplished via the control computer system (DCCs), which consists of two identical computers DCC-X and DCC-Y.

The control computer system is designed to work permanently with one control computer active and the back-up control computer in “warm stand-by”, each computer being capable of independent and complete overall plant control. Each control computer has an availability greater than 99% which results in an availability of 99,99% for two computers system (computers, peripheral equipment and input-output interface).

The keyboards associated to the computer system have been custom designed and manufactured “on demand” and they consist of dedicated keys for specific display and numeric keys for input data. The requests for display of variables and all the requests to change the setpoints and controls can be transmitted via the display keyboard. In order to reduce the probability of errors inputs when making a request or a command two different keys shall be successively pushed (i.e. ENTER and EXECUTE).

In case of a control computer (DCC) failure, the associated contacts scanner is automatically transferred to the stand-by control computer in order to process the contact inputs that will generate the alarm messages on colour CRTs. The transfer can also be done manually. When both computers fail, the reactor is shutdown and the annunciation alarm windows system only will continue to provide alarms for the systems remaining in operation after reactor shutdown. The operator can determine the cause of a trip annunciated by the alarm system, both considering the displayed alarms and analyzing the printed copy and comparing the information.

In addition to the information provided under Article 12, examples of operating design features that positively influence the operators’ capacity of control and action are summarized as follows.

Centralization

The Main Control Room (MCR) design is based on the philosophy of having sufficient information displayed to allow the operator to safely control the plant. All equipment (main control panels/desks, panels for signal processing, annunciation and alarming) and information required for the safe operation of the nuclear power plant in all its anticipated (configurations and/or situations) modes of operation are centralized in Main Control Room (MCR) in order to provide an overall control of the plant.

The information related to safety systems status, along with the information referring to the other plant systems, is sufficient to allow the operator to estimate the initiation, nature and the extent of a transient or accident and to intervene in accordance with the relevant emergency operating procedures. The display of information necessary for the operator to evaluate plant status or the evolution of certain process parameters is redundant, using conventional technique as well as colour CRTs, allows correlation of information and has a high reliability. These features, together with general characteristics of display (availability, readability, accuracy, uniformity, standardization, hierarchy) help the operator to easily understand the information.

Layout

Operator's desk is located in the MCR, in such a manner that allows him to see all the control panels, and is provided with a keyboard and a monitor associated to the computer system which constitutes the interface between the operator and DCC. Enough space is available in the MCR to allow access at the different control panels and free moving.

The control panels for the safety systems are grouped (in the left side of the MCR) and the process system control panels arrangement reflects the power generating and transport process from the reactor to the turbine-generator. Control panels are separated in four distinct groups:

a. Special safety system control panels;
b. NSP control panels, Steam generation and power generation control panels;
c. Control panels for the electric part and the auxiliary systems;
d. F/H (Fuel Handling) control panels.

In the layout of each system, consideration was given to the location of the controls based on process function and/or plant area, as well as to the location of the controlled elements. Complex process systems and electrical systems are displayed on mimic diagrams. The information is compactly displayed and grouped by channel and by operational function. For example, the instrumentation required to control a process is located near the instrumentation providing process information.

The control panels have been designed for "operator standing", because of the low number and frequency of manoeuvres that the operator has to perform from these control panels. Operator's desk and F/H panels are designed for "operator sitting down".

The annunciation windows are located on the upper part of the control panels which is slightly inclined to the operator; the indications, CRTs, Auto/Man stations of the loop controllers and sometimes certain control devices are located on the central part of the panel; the control devices (handswitches) are located on the panel's desk.

Annunciation devices

Annunciation is made in the MCR directly or on local panels, which transmit to MCR bulk alarms. Process parameters exceeding specified limits, equipment failures and actions not accomplished or incomplete are annunciated. The alarm annunciation setpoints for the situations that need operator's intervention are set so that the operator has sufficient time to react to the alarm conditions.

In order to select the alarms by importance, the following classification was made:
- centralized alarms in the MCR;
- local alarms in the field with a regrouped alarm provided in the MCR.

The MCR alarm annunciation system consists of: two colour CRTs (located on the main control panel) for alarm messages annunciation, a facility to provide a printed record of all alarm messages (on a system basis or for the entire unit, with sufficient information to enable them to be arranged in the chronological order of their occurrence to provide the sequence of events) and alarm windows located on different MCR panels. It also provides Hand-Switches Off-Normal annunciation on corresponding MCR panels.

Types of displays available on demand on monitors:
- bar charts;
- graphic trends;
- status displays;
- special displays;
- numerical variable displays;
- liquid zones displays;
- simplified process diagram displays;
- process limits and setpoints displays.

The format of the display is adequate to the task and helps the operator to determine the faults in case of an event. For example, the bar charts allow comparison between parameters, the graphic trends allow the analysis of a parameter evolution, and status display gives an overview upon systems and equipment.

Alarm windows and control panels in MCR are normally free of visual annunciation in normal mode of operation, this helping the MCR operator to identify any discrepancy or abnormal situations by the presence of annunciation from alarm windows, from Off-Normal annunciation or from discrepancies lights. Centralized alarms are selected by priority. The operator’s attention will be caught by the priority through a colour code. Alarm windows annunciate reactor trip, setback, stepback, turbine generator trips, high voltage breaker trips as well as any other relevant process alarms. The alarm windows are grouped and they correspond with system allocation on panels. Audible annunciation is also provided in association with the visual annunciation.

The annunciation system has been designed to be flexible, by allowing the suppression of low importance alarms during major events in order not to distract the operator’s attention.

Labelling

Inscriptions (labels) on the alarm windows and the alarm messages displayed on annunciation CRTs have been elaborated in two stages: first the system engineers have created them, and then they have been passed through a process of standard and suggestive abbreviation.

There have been taken a number of measures in order to optimize the balance between the lack of space and the necessity of having explicit inscriptions, as well as to reduce the need of consulting the operating manuals:
- the labels are colour coded function of the systems they refer to: safety systems,

process systems and power supply classes;
- the labels are located under the equipment;
- the texts are comprehensible, with minimum abbreviation; the abbreviations have an unique sense (so that there is no coincidence between two abbreviations coming from different texts).

Control devices

The components of the control devices are characterized by function, operating mode, aspect and reliability.

Generally, control elements are located on MCR panels so they can be easily operated, their position being correlated to the indicating devices (which sometimes confirm the action), located at operator's eye level.

The most important control devices are located in the middle of the panel. As much as possible, handswitch position succession is standardized. The handswitches are integrated in the mimic diagrams where practical. When they are not integrated in the mimic diagrams they are grouped on a system/equipment basis. Button type control devices are arranged based on the operation sequences, usage frequency and priority. The buttons that should not be activated by mistake are provided with protection, by being physically separated or protected by lids.

All the above-mentioned measures are meant to provide a support for the operator so he can maintain the skills acquired during training.

Secondary Control Area

In case of DBE (Design Basis Earthquake) or MCR unavailability, the safe shutdown condition of the plant is maintained from the Secondary Control Area (SCA).

SCA provides the necessary controls and indications in order to accomplish the following safety functions:
1) shutdown the reactor and maintain it in a safe shutdown state for an indefinite period;
2) remove decay heat from the reactor core and thus prevent any subsequent process failure which might lead to the release of radioactivity to the public in excess of allowable limits;
3) maintain a containment barrier against radioactive release;
4) display of post-accident parameters in order to enable the operator to assess the state of the Nuclear Steam Supply System (NSSS).

The equipment necessary to initiate and monitor the shutdown of the reactor and the cooling of the core is kept in four seismically qualified control panels. The SCA panels contain the controls and indications for the following main parameters and systems:
- Emergency Core Cooling System;
- Moderator temperature;
- PHT temperature;
- SG level and pressure;
- Emergency Water System;
- Dousing system;

- Containment Isolation system.

Controls, indications and alarm windows are provided for SDS#2 and a SDS#1 trip pushbutton is also provided. The reactor is maintained in a safe shutdown state by an interlock between SDS#2 and the poison extraction system.

Manual actions

The design ensures that the number of operator actions that need to be performed on a short time scale is kept to a minimum. All special safety systems actions following an initiating event are performed automatically. All automatic actions have the capability of being initiated also manually, from the MCR and SCA. The manual actions credited in the accident analysis are assumed to occur not earlier than 15 minutes after a clear and unambiguous information (alarms) requiring operator action has been received.

18.4 Measures for ensuring the application of proven technologies

An important general requirement in the Romanian regulation "Specific requirements for the quality management systems applied to the design of nuclear installations" (NMC-05) is that the design and associated design documentation are to be verified to ensure its correctness and that all specified requirements have been fulfilled. Provisions relevant to the area of design are specified also in the regulation "Specific requirements for the quality management systems applied to the activities of producing and using software for research, design, analyses and calculations for nuclear installations" (NMC-12).

The design verification can be done through reviews (supervisory review, independent third party review, etc.) and / or by testing. Complexity, novelty, safety implication of the design, standardization degree, etc., determine the extent of the design verification.

The verification requirements are identified in the engineering quality plans implemented during manufacturing, construction, commissioning and operation stages. These plans identify the design activities to be verified, the extent of verification, persons involved in verification, methods and position in the design cycle, etc. All the above requirements are covered by specific verification procedures. Any improvements in the existing design or redesign of the systems or components are subject to the same verification as the original design in order to confirm that all the existing analyses are valid and the design is correct.

The design activities can be performed only by organizations recognized or licensed by CNCAN. When the design activities are contracted to other design organizations, the contractors shall be licensed or agreed by CNCAN, or it shall be ensured by other means that the design work is verified in the same manner as mentioned above. The Design Authority for the plant has the responsibility to check that the contractors have performed such design verifications and that the particular designers have used correctly the design inputs.

Verification or certification, where required, of design reports, stress reports, seismic or environmental qualification reports, are usually carried out by the supplier or other specialized and authorized organization, in accordance with applicable codes, standards and procedures. Test requirements, procedures, assumptions, data and results are documented and records are kept for ensuring design traceability.

The design authority evaluates the test results against acceptance criteria and conclusions of the test are recorded and filed in design history files. When tests are required to be performed by a contractor, test requirements are specified in the procurement documents.

Computer software programs used for design, design analysis, plant and safety system control, safety analyses, and computer-assisted design are verified, validated and documented. Such verifications, validations and documentation are controlled through appropriate procedures.

When selecting a manufacturer's standard product, the design is subjected to review and/or testing to demonstrate the satisfactory performance of the item. Alternatively, to ensure satisfactory performance of the item, the design authority may evaluate the manufacturer’s evidence of verification.

Since the early stages of the development of the Romanian nuclear program, the contractual arrangements between the license holder and the designer/vendor have been focused on ensuring that sufficient design information is provided to ensure the safe operation and maintenance of the plant and to support the development of national competence and expertise with regard to CANDU design.

Arrangements are in place also to obtain technical advice and support with regard to any safety related issues for which external expertise would be needed, as the design authority of Cernavoda NPP maintains a close relation with the plant designer and vendor (Atomic Energy of Canada Limited - AECL) and with the other CANDU operators worldwide (through the CANDU Owners Group - COG).

18.5 Examples of design improvements implemented for Cernavoda NPP Units

The licensing basis document for each unit of Cernavoda NPP included a general overview of the design of the reference plant and the design changes to be incorporated based on the experience from the commissioning and operation of other similar NPP units (CANDU 6), results of new safety analyses, well as those needed to respond to the changes in regulations, codes and standards.

This section gives some examples of design improvements for the Cernavoda NPP Units as included in the LBDs. It should be noted that the number of design changes performed for each unit since the approval of the LBD (including changes during the phases of construction, commissioning and operation) is significantly greater than that proposed in the LBD (which only represent the notable improvements arising from the operating experience available at the time of the application for a construction license).

Cernavoda NPP, Unit 1

Unit 1 of Cernavoda NPP was commissioned between the years 1993 and 1996. The design installed and commissioned in Romania has incorporated most of the significant safety related design changes already made by other organizations operating CANDU-6 up to late 80's. Supplementary, during commissioning a few other hundreds of design changes were incorporated that originated from:

- CANDU 600 operating experience, especially Point Lepreau, Gentilly 2 and Wolsung;
- safety assessments performed in Canada following the occurrence of some incidents at other nuclear power plants;
- the probabilistic safety evaluations performed to verify the adequacy of design.

Some examples of modifications incorporated in the "as-commissioned" Cernavoda NPP Unit 1 are given below:

- modification of the control room design to consider human error factors;
- new material used for the pressure tubes (Zr-2.5%Nb);
- improved trip coverage;
- automation of the low power conditioning for the trip of shutdown systems on low pressurizer level and low boiler level;
- improvements to increase ECCS reliability;
- provisions for the post LOCA collection of leakage from ECC pumps;
- provision of redundant back-up cooling for RSW system;
- improvements of instrument air reliability;
- improvements of the containment liner to minimize the leak rate;
- provisions for annulus gas recirculation;
- provision for a facility for post LOCA sampling of Containment Atmosphere;
- improvements of the fire protection, etc.

Examples of design changes implemented after the start of operation:

- Removal of ADP functions from BLC program to an independent program - MIT (Mitigation Program) in order to avoid the failure of the ADP function at BLC program failure (clear separation between the safety function and process function);
- Modification of the start-up system to ensure complete independence of the redundant Diesel generators of the EPS;
- As a result of the thermalhydraulic analyses for review of LPECC flow capacity in case of LOCA event, a design modification for replacement of the two 100% capacity strainers for Cernavoda Unit 1 has been implemented in 2002, in order to prevent sump filter clogging in case of LLOCA and to ensure the required performance of the pump under the design basis operating conditions for a minimum mission period of three months;
- Replacement of Chiller Units;
- Replacement of the LISS injection valves;
- A new portable vacuum subsystem has been installed to clean the underwater surface of the spent fuel bay;
- The silicon rubber seals of the airlocks have been replaced with EPDM perimeter seals, that have better design parameters and are EQ qualified;
- The original strainer located on the suction line of the EWS pumps was replaced by a new strainer made by stainless steel and corrosion resistant.

The process for initiating, assessing and implementing design changes is defined by a set of plant procedures, with the aim of ensuring effective configuration control and conformance with the design basis of the plant. Information on the design change process has been provided under Article 14.

Cernavoda NPP has a feed-back program to implement the design modifications and improvements from Unit 2 to Unit 1 that ensure safety enhancement and that are reasonably practicable for Unit 1, in order to maintain an equivalent level of nuclear safety with Unit 2. Some of the design changes considered in the LBD for Unit 2 have already been implemented also in Unit 1, e.g.:

- lowering of the calandria outlet temperature to increase moderator subcooling, and consequently, improved moderator system capacity to act as a heat sink;
- PHT Liquid Relief Valves and Degasser Condenser relief valves modification that increase the PHT system overpressure protection;
- changes that minimize the positive reactivity at the reactor in the event of failure of the Liquid Zone Control pumps;
- improved valve in Feedwater System to allow the auxiliary feedwater pump operation with depressurized boilers, in case of MSLB;
- manual actuation of SDS # 1 from SCA - a seismic qualified area;
- actuation of ECC System on a new parameter (sustained low pressure on PHTS);
- automatic transfer from ECCS Medium Pressure Injection phase to the Low Pressure Injection phase.

The assessment of the reasonable practicability of the above mentioned changes, has been completed in the framework of the first Periodic Safety Review (PSR) of Cernavoda Unit 1. Also, recommendations for Unit 1 design changes resulted from the Unit 1 PSR, based on the comparison with the Unit 2 newer project, which refer to:

- manual actuation of SDS # 1 from a seismic qualified area, such as SCA;
- the environmental qualification up-grade of some Unit 1 system components.

Cernavoda NPP, Unit 2

The work on Unit 2 restarted in 2001. The engineering documentation for Unit 1was updated to be used as reference for Unit 2 and the existing facilities and buildings were recertified.

In the period for which the construction of Unit 2 was stopped, there have been many developments in the nuclear industry worldwide. For example, CANDU plants similar to Cernavoda 1 and 2 have been built and placed in service in South Korea (3 units at Wolsung) and in China (2 units at Qinshan). In addition, during this period, additional experience has been gained from the operation of CANDU plants worldwide.

All the improvements resulting from the commissioning and operating experience were considered in the process of identification of the feasible design changes for Unit 2, account being taken of the stage of the construction work. After thorough review, 156 design changes were selected for implementation on Cernavoda Unit 2. These changes can be categorized as follows:

- Design changes to meet revised licensing requirements. These changes are in response to revision of codes, standards or regulatory requirement documents. Since the original design of Unit 1 was completed, some of the codes, standards and regulatory licensing requirements have been revised to improve consistency and to increase the margin of safety. In general, these changes can be categorized as safety improvements.
- Changes due to development of CANDU technology. In general, these changes result in improved performance or reliability of operation.
- Design changes to replace equipment where the equipment used in Unit 1 is approaching obsolescence, and modernization will result in improved availability of

spare parts and maintenance.
- Other design improvements for enhancing system or station performance.

Examples of safety improvements are given below:
- Provision of a second independent steam generator crash cooldown system, to improve reliability of the secondary circuit as a heat sink for the intact loop in case of LOCA and for the failed loop for small breaks;
- Improved EWS reliability (protection against single failures);
- Automation of start-up of LP ECC to eliminate the need for operator action to manually switch from MP to LP ECC operation 15 minutes after a LOCA;
- provision for redundant flow paths for ECC pump suction from dousing tank and redundant dousing tank level instrumentation;
- Provision of an on-power gross containment leakage monitoring system, to give additional assurance of containment boundary integrity for the periods between the full-scale leak rate tests;
- Provision of Hydrogen igniters to prevent Hydrogen accumulation in the Reactor Building in case of LOCA;
- Increased chromium content of lower outlet feeders, to ensure better protection against flow-induced corrosion and erosion;
- Post-Accident Monitoring System;
- Modification to ensure Environmental qualification for all systems' components required to manage and mitigate consequences in Reactor Building after steam line or heat transport pipe break (LOCA).

Since the approval of the LBD, there were more than 200 additional changes implemented in Unit 2. All the design changes were implemented through a rigorous Design Changes process that required the approval of the designer for all the special safety systems. All design changes were assessed for impact on plant safety and when it was the case (for the modifications classified as major) they were also submitted to CNCAN for review and approval.

Examples of design changes implemented after the start of operation of Unit 2:
- The original strainer located on the suction line of the EWS pumps was replaced by a new strainer made by stainless steel and corrosion resistant;
- The Alarming Area Gamma Monitors (AAGM) have been upgraded by replacing the silicon detectors with ion chamber detectors and also, a new gamma detection loop has been installed in Service Building, near ECC pumps;
- A connection bridge was built between Unit 1 and Unit 2 service buildings in order to ensure a better operation of both units.

Cernavoda NPP, Units 3 and 4

The construction of Units 3 and 4 started in the early 1980s but was stopped in 1992 when the Government decided to focus resources on the completion of Unit 1. When construction works on Units 3&4 were halted, the civil buildings and structures, including the reactor building, the service building, the turbine-generator building were significantly developed. The existing civil structures have been assessed against the requirements of the latest codes and standards and improvements will be implemented as far as reasonably practicable.

The Reference Plant for Cernavoda Units 3 and 4 will be the as-built Cernavoda 2 plant, and will include the changes required to meet the latest Codes and Standards, any licensing mandated changes, design modifications to deal with obsolete equipment and address operational experience feedback from other CANDU plants identified before the project start.

The preliminary list of design changes has been derived from the following sources:
1. The Deloitte feasibility study produced in 2006 for Cernavoda Unit 3 to identify potential design changes;
2. Canadian Nuclear Safety Commission (CNSC) generic action items;
3. Identification of design changes resulting from Cernavoda Units 1 and 2 and other CANDU 6 operating experience (OPEX) available from AECL's feedback monitoring system;
4. Identification of design modifications resulting from new editions of codes and standards;
5. Identification of design changes not implemented on Cernavoda Unit 2 due to the advanced state of construction and which result from known issues such as generic action items;
6. Identification of design changes resulting from the Cernavoda Units 1 and 2 probabilistic safety assessments;
7. Identification of potential design changes resulting from the review of WENRA reactor safety reference levels and CNSC RD-337;
8. Identification of design changes resulted from Fukushima lessons learned.

The design changes currently under consideration aim to ensure that the design is in line with the current requirements for new NPPs. The recommended targets for CDF and LRF for new reactors ($CDF<10^{-5}$, $LRF<10^{-6}$) are also a target for the design of the Units 3 and 4.

18.6. Safety upgrades post - Fukushima

After the Fukushima Daiichi accident, safety improvements have been implemented in accordance with the National Action Plan Post-Fukushima (presented in Appendix 2 of this report).

The licensee has increased the protection against SBO (Station Black-Out) and LOUHS (Loss of Ultimate Heat Sink) scenarios by specific design changes and operational measures, so that such events would not lead to fuel failures. Several design improvements have been identified and have been implemented to maintain fuel cooling during severe accident conditions and to enhance the capability to maintain containment integrity in case of severe accidents.

The main improvements are summarized as follows:

- Two new emergency operating procedure for responding to SBO has been developed and issued.
- Procurement for each unit of an additional mobile DG set (1.2 Mw) and the connections to the existing EPS buses;
- Provision of a mobile Diesel engine driven pump and flexible conduits to supply fire water trucks, under emergency conditions;
- Provision of two electrical mobile submersible pumps powered from mobile DG to supply firewater truck, under emergency conditions;

- Provision of two mobile Diesel generators (110Kw) for electrical power supply of instrumented panels and also to domestic water pumps to supply firewater truck, under emergency conditions;
- In order to minimize the time for connecting the mobile Diesel generators to the critical loads, special connection panels have been installed.
- The seismic robustness of the existing Class I and II batteries has been improved;
- Provision of two separate means to manually open the MSSVs after a SBO;
- Provision of connection facilities required to add water using fire fighters trucks and flexible conduits to supply the primary side of the RSW/ RCW heat exchangers and SGs under emergency conditions;
- Facilities for water addition to the Calandria Vessel and to the Calandria Vault, and increase of the in-vessel retention reliability;
- Installation of PARs for hydrogen management;
- Provisions of a seismic qualified fire-water line to Spent Fuel Bay from the S/B exterior, and of natural ventilation of vapours and steam evacuation;
- Seismic qualification improvement of the on-site Emergency Control Centre;
- Installation of satellite phones in each unit Main Control Room (Intervention Support Centre) and Secondary Control Area.
- Emergency filtered containment venting systems;
- Improvements to the instrumentation necessary to support SAMG implementation;
- Special system for hydrogen concentration monitoring in different areas of the Reactor Building.
- Completion of the off-site Emergency Control Centre.

The above mentioned modifications refer to Units 1 and 2 of Cernavoda NPP. The majority of the safety upgrades dedicated to increased protection against severe accidents had been included in the LBD for Units 3 and 4, before the Fukushima accident.

The seismic walk-downs and subsequent seismic robustness analyses done as part of the seismic margin assessment have not revealed a need for any safety significant design change. However, several recommendations resulted from these inspections and have been included in the regular plant seismic housekeeping program.

Several measures to improve protection against flooding by flood resistant doors and penetrations sealing have been implemented. Also, sand bags have been provided on-site to be used as temporary flood barriers, if required.

The reviews performed after the Fukushima accident confirmed the safety margins available and the design robustness against severe accidents and conditions caused by extreme external events.

More detailed information has been provided in the Romanian National Report for the 2nd Extraordinary Meeting under the Convention on Nuclear Safety.

18.7 Significant developments for the last reporting period

Cernavoda NPP has continued upgrading the safety of its operating units, taking account of the latest standards, available operational experience feedback and the results of research and development activities. In addition to the design improvements implemented post-Fukushima and described in section 18.6, the following represent examples of important design upgrades:

- Since 2013, the station continued to focus on further improving the Cernavoda NPP project, to achieve safer and more reliable plant operation. Examples of design changes implemented are listed below: Following the recommendations of WANO GAP SOER 11-1 “Large Power Transformers Reliability”, the station large power transformers have been equipped with an on-line dissolved gases detection and alarm system;
- Implementation, at large power transformers, of a system to prevent explosion hazard (SERGI);
- Design modification to increase redundancy of the cooling circuit for the Auxiliary FW pump, to be used during plant outages;
- Change of the EPS Diesels starting system in order to ensure two independent groups, each one composed by a rectifier, a battery and a starter;
- Modification to improve reliability of the cooling system for U1 Instrument Air compressors;
- In case of a non-seismic induced Station Blackout event a design modification has been implemented in order to ensure a water make-up path from fire water hydrant to the Calandria Vault;
- Considering the OPEX from an external event “Stepback with Control Absorber (CA) Rod 2 or 3 stuck”, a design modification of Mechanical Control Absorber Logic within RRS control program was implemented;
- The controls of the DN Scan system (location of failed fuel) were refurbished. This design modification replaces the old control system with a modern system;
- The redundancy of electrical power supply Reactor Building air dryers (D2O recovery system) was increased by providing a second source for each drier;
- The 110 kV Station has been refurbished to increase its reliability;
- Replacement of the obsolete temperature control loops for the spent fuel bays cooling; the new loops are equipped with programmable digital controllers for better temperature control;
- Refurbish the Cathodic protection for the U1-EPS underground fuel tanks;
- Increase the reliability of the U1 main electrical generator by replacing the Excitation System with a new generation one;
- manual actuation of SDS # 1 from SCA - a seismic qualified area;
- Improve reliability of U1 Standby Diesel Generators by installation of an air drying system on the starting air system;
- actuation of ECC System on a new parameter (sustained low pressure on PHTS);
- automatic transfer from ECCS Medium Pressure Injection phase to the Low Pressure

Injection phase,

- replacement of the Service Building/Reactor Building ECC Expansion Joints with new models in order to enhance the internal liner stiffness in reverse flow conditions (for Medium Pressure to Low Pressure transition);
- elevate the Dousing Level Measurement Loops (belonging ECC System) in order to avoid the unavailability in case of Reactor Building flooding due to beyond (extended) design basis accident;
- qualification of the PHT Headers Pressure Loops for Earthquake and Severe Accident Conditions and installing Pressure Indicators in SCR (Secondary Control Room); these indications are used for subcooling margin monitoring for SAMG (Severe Accident Monitoring Guide).

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 program 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 license to the regulatory body;
(vii) programs to collect and analyze 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.

19.1 Description of the licensing process for commissioning and operation

The general licensing process has been described under Article 7. This section only provides additional information specific to the licensing process for the stages of commissioning and operation.

The current main regulations containing provisions on the licensing process for commissioning and operation are:
- NSN-21 - Fundamental nuclear safety requirements for nuclear installations (2017).
- NSN-22 - Regulation on the licensing of the nuclear installations (2019).

19.1.1 Commissioning

Regulatory requirements and licensing process for the commissioning stage

The main document based on which the Commissioning License is issued is represented by the Final Safety Analysis Report (FSAR) - which includes the following:
- updates on technical evaluations/assessments and safety analyses performed at PSAR stage;
- the results of the environmental monitoring program on-site and for the surrounding areas;
- a description and analysis of the structures, systems and components of the

installation, with emphasis upon performance requirements, the technical justification of their selection and the evaluation required showing that the safety functions will be accomplished;
- the types and quantities of radioactive materials expected to be produced during operation and the means provided for controlling and limiting the radioactive effluents and the associated radiation exposures;
- the organizational structure, including the responsibilities and authorities, and personnel training programs;
- managerial and administrative controls to be used to ensure the safe operation of the facility;
- plans, programs and procedures for pre-operational testing and initial operation;
- plans for conduct of the normal operation, including maintenance, surveillance, and periodic testing of structures, systems and components;
- emergency plans and emergency preparedness arrangements.

General regulatory provisions, focused on the quality management of the commissioning activities, are given in the regulation “Specific Requirements for the Quality Management Systems Applied to the Commissioning Activities of Nuclear Installations” (NMC - 09).

CNCAN also establishes detailed requirements with regard to the licensing deliverables needed to demonstrate compliance with nuclear safety requirements, for each milestone of the commissioning stage. The licensing deliverables are constituted by the documentation that is submitted to CNCAN as support of the licensing applications, including the applications for the approvals associated with each of the milestones. The milestones of the licensing process are given as follows.

Phase A Milestones
Pre-operational and Operational testing:
- Acquire and store D2O – AD;
- Moderator D2O Fill – MD;
- Reactor Building Leak Rate Test – LT;
- Acquire and Store Nuclear Fuel - AF;
- Hot Conditioning of the Heat Transport System - HC;
- Power Failure (Loss of Class IV Power) – PF;
- Load Fuel – LF;
- PHT Fill with D2O – HD;
- Hot Performance Tests with D2O – HP.

Phase B Milestones
Tests at Low Power:
- First Reactor Criticality – CR

Phase C Milestones
At Power Testing:
- Power Increase to 5%FP – PI;
- Power Increase to 25% (PP1), 50% (PP2), 75% (PP3) and 100%FP (PP4);
- Tests at Full Power Operation (FP).

For the commissioning stage of each of the Cernavoda NPP units, a licensing schedule was established, including the provision of separate approvals for each licensing milestone, based on the appropriate support documentation. Based on the experience gained during the commissioning of Unit 1, a similar process was used also for Unit 2, with regard to both the activities of the commissioning organization and the regulatory activities for review and inspection. Based on the experience gained and practices used by CNCAN during licensing process of Cernavoda 1 NPP, more detailed requirements for various licensing milestones have been established for Cernavoda 2 NPP. Since the processes followed for the commissioning of Units 1 and 2 of Cernavoda NPP are very similar, the information provided in this section is applicable to both units, unless specified otherwise.

Overview of the Commissioning Program

The commissioning Program for Cernavoda NPP consisted of comprehensive plant systems functional and operational tests and integrated tests. The main objective was to confirm that the entire plant is ready for normal full power operation as designed.

The principal safety functions and requirements for the safety related systems, structures and components are documented early in the design process, in Safety Design Guides (SDGs). The list of all the systems and structures deemed to have a safety function is included in the SDGs and for each item an explanation is given on the specific safety function(s). From there the high level safety requirements are derived to ensure effectiveness of the specified safety functions.

With SDGs giving high-level safety design requirements, other project documentation specifies more detailed requirements. Examples of such project documentation include other design guides, design manuals, program specifications, safety (thermal-hydraulic, stress, reliability) analysis reports, manufacturer’s manuals, etc.

The Commissioning Specifications and Objectives (CSOs), which include Safety Objectives, define the system commissioning requirements necessary to assure that sufficient checks and tests are performed to demonstrate that the plant systems comply with the applicable design, safety and regulatory requirements. Unit 2 CSOs incorporated the relevant Key Commissioning Objectives (KCOs) developed during Unit 1 commissioning.

The commissioning program was conducted on a milestone basis in parallel with the Licensing Program agreed with CNCAN. Each milestone was achieved, and documented processes were set in place to demonstrate that:

- the testing activities were well defined and clearly detailed and the objectives of the tests were well established, in such a manner that the equipment and systems are placed in service, design specifications confirmed, and safety assumptions validated.
- the testing activities were scheduled, reviewed and performed without jeopardizing at any time the plant safety, and the status of the plant was appropriate for the corresponding commissioning activities.
- the process of test results evaluation provided assurance that all the applicable assumptions and conclusions included in the safety documentation were adequately demonstrated.
- all the required operating documentation including baseline data collection forms for systems and components was prepared and available to the operating personnel.
- test records essential to demonstrate that commissioning activities have been performed in accordance with specified requirements were collected, assembled, validated and

filed to storage by the Operations Document Control Centre, as a part of the individual system commissioning packages.

- the Commissioning test results together with the process in place to review, evaluate and approve them, referred to as Commissioning Completion Assurance (CCA), were used to obtain approval to proceed beyond the licensing milestones and release hold points agreed with CNCAN.

All of the above were sustained by a framework of processes described within the following procedures:

- System Commissioning Procedures;
- Standard Commissioning Procedures;
- Commissioning Records and Files;
- Transfer of Operating Control to Shift Crews;
- Commissioning Completion Assurance (CCA);
- Commissioning Technical Process;
- Commissioning Planning Process;
- Commissioning Reports;
- Commissioning Specifications and Objectives;
- Work Permit and Equipment Guarantee System during Commissioning;
- Temporary Modifications during Commissioning Prior to Fuel Load;
- Temporary Modifications during Commissioning after Fuel Load;
- Commissioning Execution Process;
- Operating Manual Tests;
- Work Request System;
- Work Plans;
- Operating Flowsheet Preparation;
- Operating Manuals;
- Commissioning Temporary Operating Procedures;
- Preparing, Issuing and Revising Commissioning Program Documents and Directives;
- Document and Template Management;
- Commissioning / MT Engineering Interface;
- Integrated Commissioning Tests Coordination;
- Commissioning Unplanned Event Reports (CUERs).

The Commissioning Program Phases and Objectives are summarized in Table 19.1.

After completion of system by system commissioning in phase A and with appropriate systems turned over to Operations, nuclear operation began with the first approach to criticality of the reactor and subsequent low power testing.

The main purpose of these tests was to detect and correct any problems related to design, fabrication or installation of equipment and instrumentation that could affect the optimal operation of the reactor or could result in the reactor being operated in an unanalyzed configuration (i.e. in a state not covered by the safety analysis). The following checks were performed:

- the reactor regulating system performance at low power;
- the performance of reactor shutdown systems;
- the fundamental characteristics of the reactor core by reactivity and flux distribution measurement and assessment.

Table 19.1 – Commissioning Program Phases and Objectives	
Commissioning Phases	**Main Objectives**
Commissioning Phase A Pre operational Testing Hot conditioning Initial fuel loading Zero Power Hot Functional Testing	▪ To verify the adequacy of plant design and prepare the plant systems and equipment for power operation ▪ To confirm that critical parameters and system performance are as designed before taking the plant to high power ▪ To test systems to meet jurisdictional requirements ▪ To operate the systems in the pre-power mode and demonstrate their operability ▪ To load the initial fuel charge ▪ To obtain baseline data for systems and component performance
Commissioning Phase B Initial criticality and Low Reactor Power Physics Testing	▪ To confirm reactor core and reactivity mechanisms configuration as per design ▪ To confirm the effectiveness of both shutdown systems ▪ To confirm the neutronic instrumentation performance ▪ To confirm reactivity coefficients applicable to the reactor at low power ▪ To validate the reactor core model ▪ To demonstrate the adequacy of the Reactor Regulating System
Commissioning Phase C (at-power testing)	▪ To commission feed water, turbine, main generator and auxiliaries ▪ To confirm that under both steady state and upset conditions, reactor and balance of plant parameters behave as per design ▪ To demonstrate that plant can be safely operated at any power level up to full power under expected normal and abnormal operating conditions

All the prerequisites for the approach to criticality were fulfilled. In other words, all the required systems for the start-up of the reactor were available and in an operational state. This included both reactor shutdown systems.

Prerequisites for performing a test were specified in each individual test procedure. The sequence of testing was outlined in start-up test sequences, such that required prerequisite testing was completed prior to performing a subsequent test. Any special test instruments required were specified to be installed, calibrated and checked in the test procedure that specified the test equipment. Where these test instruments were not intended for future use, they were removed from the systems and systems returned to their normal states.

A special procedure was set-up to issue a "Summary Test Report" (STR) by each commissioning engineer after each test of power step of Phase B (or C). The purpose of the STRs was to assure that:

- The Phase B or C or power step of Phase C commissioning program clearly demonstrated that the systems involved met their design intent.
- The results of the commissioning program showed that the systems involved operated within the limits and according to the performance stated in the Safety Report.

- The plant could go into the next phase or power step of Phase C.

Through the review processes set in place for the verification and assessment of the Commissioning Test results it was ensured with reasonable confidence that all the objectives were met and the assumptions and conclusions from the safety support documentation were adequately demonstrated during Phase B Commissioning.

Examples of phase B tests:

- SDS#1 trip test;
- SDS#2 trip test;
- Power manoeuvres to verify RRS response;
- Stability check of Average Zone Level;
- Reactivity calibration of Liquid Zone control System;
- Transfer of RRS control from DCCX to DCCY and back;
- Manual stepback test;
- Reactivity calibration of Adjuster Absorbers, mechanical control absorbers, shut off rods and moderator poison addition system;
- SDS#1 and SDS#2 Ion Chamber shutter speed;
- Confirm response to loss of RRS at low power.

Examples of phase C tests:

- Transport System parameters at various power levels;
- Complete HTS LRV Hot Stroke Timing Tests;
- Functional Test of DCC restart and transfer of control at 2% FP;
- Complete thermosyphoning test on Main Heat Transport System;
- Dual Computer Failure Test at 15%FP;
- Monitor Solid Control Absorber System response to the dual DCC failure;
- Monitor system response to dual DCC failure;
- Load Rejection Test at various power levels;
- Loss of class IV test;
- SDS#1 and SDS#2 trip tests.

Regulatory Surveillance Program

The detailed program for tests to be performed on a system by system basis and for integrated tests for all phases has been elaborated by the licensee and submitted to CNCAN for review and approval. The program, including specific safety objectives and acceptance criteria has been reviewed for compliance with the design intent and the safety analyses and approved by CNCAN. From this program, safety relevant tests have been selected to be witnessed by CNCAN inspectors and included in the regulatory surveillance program (RSP).

CNCAN program for surveillance of the commissioning activities for Unit 2 included more than 180 Witness Points (WP) for all the phases of the commissioning program. The Hold Points (HP) coincided with the licensing milestones.

During the commissioning stage, the regulatory authority granted the following permits/approvals:

- permit to load fuel;
- permit to load D_2O in the Primary Heat Transport System;
- permit for the first criticality;

- permit for power increase up to 5% FP;
- permits for power increase in stages, up to 100% FP.

Before granting each of these permits, CNCAN inspectors performed comprehensive inspections and verification of documentation related to the status of construction and commissioning activities for systems important for safety, as well as verification of results of important tests like reactor building leak rate test, channel flow verification, loss of class IV power supply, loss of both digital control computers, thermosyphoning test, etc.

As an example, with regard to the assessment of the project status for the first criticality, the licensee submitted to CNCAN, in compliance with the Commissioning License conditions, a report regarding the plant status, containing a detailed review of all scopes of work that have an impact on the plant readiness for criticality. The results of the review had to demonstrate that the activities have been completed as necessary for ensuring safe and reliable plant operation.

This report was submitted to CNCAN in support to the application for the permit for reaching first criticality. The report took into consideration the following activities:

1. Systems, structures and equipment turnover from Construction Department to Commissioning Department, clarification of deficiencies, completeness of as-built documentation;
2. Systems, structures and equipment turnover from Commissioning Department to Execution/Operations Department;
3. Commissioning activities;
4. Clarification of deficiencies;
5. Design changes;
6. Radiation protection program (procedures, preparing, equipment);
7. Reference Documents and Station Instructions;
8. Personnel training (based on the minimum training requirements);
9. Training manuals (elaboration and approval for use);
10. Chemical control (safety related systems);
11. Quality management system;
12. Physical protection;
13. Operating manuals (preparation, approval and acknowledgment);
14. Operational flowsheets (revised);
15. Operating manual tests (preparing, approval and acknowledgment);
16. Call-ups and routines (elaboration, approval, acknowledgement);
17. Maintenance programs and procedures (elaboration, approval, acknowledgement);
18. Housekeeping and housecleaning (equipment, systems, buildings, site).

The adequacy of the commissioning tests was judged based on the review of the test results, which have to demonstrate that all the relevant requirements and procedures have been observed and that safety objectives and acceptance criteria are met. The review of acceptance criteria formed part of the review of the document containing specific commissioning safety objectives and acceptance criteria for all safety related systems, which has been approved by CNCAN well in advance of the actual tests performance. The commissioning test results were listed in the commissioning completion assurance reports (CCA) containing a comparison to the acceptance criteria.

The regulatory surveillance plan (RSP) enabled CNCAN to effectively control step by step the commissioning process to verify that the plant, as built, meets the design safety requirements.

Meeting of Pressure Vessel Authority (ISCIR) requirements was a prerequisite for obtaining the licenses and permits issued by CNCAN. The reactor coolant pressure boundary was subject to a pre-operational hydrostatic test and leakage test. Periodic inspection consists of visual inspections, surface inspections, volumetric inspections, integrative inspections, dimensional inspections, etc., in compliance with the provisions of accepted codes and standards.

19.1.2 Trial Operation

The trial operation license is granted by CNCAN based on the first revision of the Final Safety Analysis Report, which includes the results of the commissioning phase (conclusions of the commissioning reports, the achievement of key commissioning objectives, etc.). Also, some other documents regarding the assessment of significant changes from safety point of view and the status on the implementation of different station programs are submitted to CNCAN as support documentation for the license. Summary of these station programs is presented below:

- Nuclear Safety Policy;
- Reliability Program;
- Unplanned Events Assessment Program;
- Safeguards Program;
- System Surveillance Program;
- Radiation Safety Program;
- Radiation Waste Management Program;
- Effluent and Environmental Monitoring Program;
- ALARA Program;
- Emergency Preparedness and Response Program;
- Fire Protection Program;
- Quality Assurance Program;
- Training Program;
- Design Modification Control Program;
- Periodic Inspection Program;
- Maintenance Program;
- Housekeeping Program;
- Safety Analyses Strategic Program.

19.1.3 Operation

For the first operating license, each of the Cernavoda NPP Units has prepared a second update of the Final Safety Analysis Report, to include the main results obtained during the trial operation period.

The reports on the design modifications and the status of the station programs were updated. A special focus was directed to the assessments of the unplanned events and the major objectives during that period, as for example the annual planned outage.

The operating license has then been renewed periodically. The main support documents based on which the license was granted were the revisions of FSAR which included all the design changes implemented in that period. Also, the applications contained descriptions of the major plant processes including the surveillance, configuration management, preventive maintenance, training, etc. and the implementation status of the actions required by CNCAN.

The Final Safety Analysis Reports (FSAR) for the Cernavoda NPP Units are reviewed and updated periodically. The updates to the FSAR are submitted to CNCAN and address mainly the following aspects:

- new or updated deterministic safety analyses;
- new or updated probabilistic safety assessments;
- design and procedural changes;
- implementation of actions resulting from the PSR program;
- implementation of actions resulting from various safety reviews and from operational experience feedback;
- the status of the plant programs with regard to:
    - physical condition of the nuclear power plant;
    - control of modifications;
    - systems surveillance;
    - ageing and environmental qualification;
    - radioprotection;
    - environmental impact;
    - organization and administration;
    - shift structure for maintenance and operating personnel;
    - plant personnel training;
    - periodic inspections;
    - systematic revision of spare parts;
    - preventive maintenance;
    - emergency planning;

Based on the results of the surveillance program and periodic review of safety performance, the station established a set of safety performance indicators, which are reported monthly to the station management. Also, the safety performance is reported quarterly to the regulatory authority via Quarterly Technical Reports (QTR). The fourth QTR presents a safety performance review of the past year.

In accordance with the regulatory requirements, Quarterly Technical Reports present also monitoring results regarding:

- reliability and reactor safety;
- station performance;
- production summary and outages;
- station operations (plant upsets, reactor performance and fuel management, core monitoring);
- reportable events (description, root causes, corrective actions and recommendations);
- plant changes;
- nuclear fuel;
- heavy water management;
- controlled radioactive sources management;
- radioactive material transportation;
- radiation control & employee safety;
- radioactive waste management;

- radioactive effluents;
- environmental monitoring;
- alarms;
- fire protection;
- reactor safety assessment;
- special safety systems;
- stand-by safety systems;
- human resources/training;

CNCAN staff performs a daily check of plant status by means of daily reports issued by CNCAN resident inspector and Shift Supervisors Log made available by the licensee.

19.2 Operational Limits and Conditions

In compliance with the regulatory requirements, the FSAR includes a chapter with the technical limits and conditions for operation, established on the basis of the analyses and evaluations included in the FSAR and amendments thereto. The technical limits and conditions include items in the following categories:

a) Safety limits and the setpoints for actuation of the safety systems;
b) Limiting conditions for operation;
c) Surveillance requirements (relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met);
d) Design specific features (those features of the installation such as materials of construction and geometric arrangements, which, if altered or modified, would have a significant effect on safety and are not covered in categories described in paragraphs a), b) and c) above);
e) Administrative controls (relating to organization and management, procedures, recordkeeping, review and audit, and reporting necessary to assure operation of the facility in a safe manner).

The OLCs are derived from the safety analysis included in the Chapter 15 of FSAR and are approved by CNCAN as part of the Operating License. Chapter 16 of the FSAR is dedicated to the description of OLCs and of their technical bases. The licensee cannot change the OLCs them without prior approval of the Regulatory Authority.

A fundamental requirement of nuclear safety is to operate and maintain the nuclear power plant within a defined "safe operating envelope" in accordance with the design intent and the licensing basis. The safe operating envelope is defined by the Final Safety Report. Specific operating limits as resulted from the "safe operating envelope" are added to the safety limits as defined by the safety evaluations.

The "safe operating envelope" is defined by a number of safety requirements from which the most important are:

- Requirements on special safety systems, and safety related stand-by equipment or functions, e.g. set points and other parameters limits, availability requirements.
- Requirements on process systems, e.g. parameter limits, testing and surveillance principles and specifications, including performance requirements under abnormal conditions.

- Pre-requisites for removing special safety systems and other safety related or process stand-by equipment from service.

The safe operating envelope is implemented by means of the OLCs, which are included in the set of operating documents consisting of Operating Policies and Principles, Impairment Manual, Operating Manuals and Operating Manual Tests. These operating documents support the fulfilment of the Operating License conditions and ensure that the plant will be operated in safe conditions.

As it is the case with the majority of CANDU units around the world, Cernavoda NPP Units have the Operating Policies and Principles (OP&P) as the top tier document in the hierarchy of operating documentation, establishing the safe envelope the plant must be operated within. This document states operating rules, principles and limits to maintain the plant in a safe analyzed state. It also describes the interface between plant management and the regulatory body. The OP&P document contains safety systems licensing limits, basically defining minimum system configuration to meet availability targets and to ensure the integrity of the physical barriers against radioactive releases.

The Impairment Manual provides further assistance for the operator to determine system availability. The Impairment Manual contains also the required actions to be taken for various safety systems or safety related systems impairments that render those systems less than fully capable to perform their functions as per design. For Special Safety Systems, which are dormant systems, specially designed to protect the public from radiological risk, a hierarchy of three levels of impairment has been defined with “Level 1” being the most severe and “Level 3” the least severe. For each level of system impairment specific actions are designated. Alarms have limits conservatively chosen to early alert the operator when impairment limits are challenged.

All operating personnel directly responsible for the conduct of operations are subjected to a rigorous selection, training and examination process to acquire and demonstrate the necessary knowledge and skills. An integral part of the training program (that is presented in detail under Article 11) consists of specially designed training courses to explain the rationale for all OP&P limits and conditions. All modifications to plant design and/ or approved limits include, prior to their implementation, the provision of appropriate operator training on the changes and their effect. All changes to OP&P are approved by CNCAN and any OP&P limit or condition violation is an event reportable to CNCAN.

The OP&P is periodically reviewed and updated as necessary, based on the results of the latest safety assessments performed, operating experience feedback and various modifications (including organizational changes and modifications to plant systems, processes and procedures).

19.3 Procedures for normal operation

The operating license issued by CNCAN includes specific references to documents such as Operating Policies and Principles, Maintenance Philosophy and Program, Integrated Management Manual. All these documents include, directly or by reference to appropriate procedures, rules that must be followed in performing activities related to operation, maintenance, inspection and testing.

The compliance with the requirements included in the operating license and in the documents specifically referenced by this document is mandatory for the license holder and any deviation must be timely reported to CNCAN.

The OP&P contain the general policies and limits that govern the operation of the station and the responsibilities of operating personnel. The OP&P is not as detailed as other operating procedures (e.g. systems Operating Manuals). However, it includes rules according to which the operating activities have to be authorized. Consequently, compliance with the articles of the OP&P ensures that, in the event of an expected or unforeseen situation, operation will be managed with a minimum of adverse effects.

The OP&P does not apply only to personnel performing operating manoeuvres, but to all personnel taking part in the operation of the station. Therefore, the rules established by the OP&P must be known and complied with by members of all services and administrative units working at the site. One of the main responsibilities of the Shift Supervisor is to ensure that station activities comply at all times with the OP&P, especially in situations that are not covered in operating manuals. To assist him, the Control Room Operator is also qualified to apply OP&P requirements in normal and abnormal operating situations.

OP&P require that Special Safety Systems and the other safety related systems are subjected to regular testing where their reliability or effectiveness cannot be inferred from normal operating experience. Test intervals are consistent with reliability evaluations contained in current licensing submissions. The station Surveillance Program satisfies this requirement.

The Surveillance Program includes planned activities carried out to verify that the plant is operated within the prescribed operational limits and conditions, and to detect any deterioration of structures systems and components that could result in unsafe conditions. These activities can be categorized as:

- Monitoring plant parameters and system status;
- Checking and calibrating the instrumentation;
- Testing and inspecting structures, systems and components;
- Test results evaluation.

The aim is to verify that provisions made in the design for safe operation and confirmed during construction and commissioning, continue to be adequate throughout the lifetime of the plant. At the same time, the verifications are aimed at ensuring that the safety margins are both adequate and provide high tolerance for anticipated operational occurrences, errors and malfunctions. The Surveillance Program covers mandatory testing, preventive maintenance and inspections.

Detailed procedures are prepared to cover all normal, abnormal and emergency conditions. The OP&P document specifies the operating boundaries that are an integral part of the written instructions to operators, and the authorities of the station staff. Safety margins are provided for all limits by means of staggered alarms designed to maintain high confidence that OP&P limits are not exceeded during plant transients from normal operation or in the event of a plant system breakdown.

All normal operating procedures (including systems Operating Manuals) are controlled and approved instructions that support the operational strategy for preventing unsafe conditions of the plant. The alarm response procedures (ARM, WARM, and FARM) are instructions for the anticipated abnormal occurrences; their strategy is to provide the necessary instructions to limit the transient frequency.

The majority of procedures are written in English since station annunciation is in English, but a decision was made to translate procedures for selected areas or systems. Appropriate training was provided to all the originators, procedure reviewers and users. Where procedures are available both in English and Romanian, priority is given to the Romanian version if differences exist. All station personnel must follow applicable procedures and the necessary approvals must be obtained prior to any deviation from any procedure.

Plant equipment and controls in the main control room are only operated by operators licensed by CNCAN or under the direct supervision of these operators. Continuous training and refresher training including full scope simulator guarantees that the level of knowledge and skills is adequate to support safe plant operation under both normal and upset conditions. Standards are set and expectations are communicated by plant management in various types of documents. All are reinforced during periodical evaluations including simulator training sessions, coaching and observation.

The set of operating procedures for Cernavoda NPP includes documents in the following categories:

- Operating Manuals (OM);
- Annunciation Response Manuals (ARM);
- Window Alarm Response Manuals (WARM);
- Field Annunciation Response Manuals (FARM);
- Standard Operating Sequences (SOS);
- Overall Unit Operating Manuals (OUOM);
- Abnormal Plant Operating Procedures (APOP);
- Severe Accident Management Guidelines (SAMG);
- Emergency Response Operating Manual.

Initially, the operating procedures were developed by the Technical Department using equipment/ systems specifications from design manuals, guides and safety requirements, for all station systems. In the last years the decision was made to format all operating documentation using INPO guides, and a new dedicated procedure writing group was organized as part of the Operations Support Group.

All individual system OMs include references to station OP&P for easy access to all limits applicable and reflect the limitations specified in the OP&P. They include also normal and some abnormal operating procedures. The process is described by the station procedure “Operating Manual Content”. The same document describes the format for the Annunciation Response Manuals since they are derived from the original Operating Manuals as alarm and operator actions to stabilize and troubleshoot the individual systems.

Temporary operating instructions (OI) are issued anytime a change is needed in one of the OM’s until a new revision is in place, or to provide operators with information for new systems/ equipment, in the absence of an OM. The OIs are reviewed periodically to maintain the validity and cancelled when no longer required.

Standard Operating Sequences (SOS) were developed for jobs of a recurrent nature and with a certain degree of complexity to justify the use of a standard document.

For specific situations such as plant start up and shut down or plant upsets, the coordination between various system operation is provided in the form of Overall Unit Operating Manual (OUOM) which is a PERT diagram representation of the necessary steps or procedures (from systems' OMs) to be performed for a particular plant state to be reached.

All plans shall include hazards and contingency actions for any adverse situations that may develop from the sequence of steps/ events to be performed. CNCAN approval is also necessary for activities that may challenge safety envelope as stated in OP&P document. Multiple layers of reviews and approvals are built in to process of developing non-routine activities.
The process, including detailed steps of preparation, review, safety and operational screening and approvals, including those by Station Manager and CNCAN, is described in the station procedure governing the Work Plans.

Information on the surveillance programs and the associated procedures has been provided under Article 14, section 14.3.2.

19.4 Response to anticipated operational occurrences and accident situations

Specific station procedures are in place for mitigating the effect of an abnormal event initiator and direct the operator to bring the plant to a safe state that usually is defined as the cold shut down state. The response to anticipated operational occurrences and to accidents is controlled through a hierarchical system of station procedures as follows:

- Operating Manuals and Alarm Response Manuals – include procedures used by the plant operation staff during routine operation of the nuclear power plant and its auxiliaries and also information regarding abnormal operation and the alarm functions associated with the plant systems (set points, probable cause, operator response, etc.);
- Impairment Manual - includes actions to be taken by the operator in case that operation is close to or getting outside the specified limits of the safe operating envelope;
- Abnormal Plant Operating Procedures (also known as Emergency Operating Procedures (EOPs)) - which direct the operator during accident conditions (for design basis and design extension conditions) and are designed to restore the plant to a safe condition and ensure protection of the health and safety of the plant personnel and of the general public;
- Severe Accident Management Guidelines – which direct the operators and technical support groups during severe accident conditions and are designed to minimize the severe accident consequences and to bring the plant in a stable end state.
- Emergency Response Operating Manual - includes operator's actions in case of radiological, medical and chemical incidents, fire events, extreme weather conditions, spent fuel transfer/ transport incidents, spent fuel bays and spent fuel dry storage facility incidents, loss of Main Control Room; this manual provide the necessary criteria to classify the emergency and easy access to each of the sections containing the necessary measures to be taken for the different types of emergencies, with the overall process being governed by the on-site Emergency Plan.

Administrative procedures are in place to express the management expectations for the operating crew when dealing with plant transients, aiming to eliminate confusion and obtain consistency in crew performance. These documents set responsibilities and give authority to licensed personnel to recognize the abnormal event and mitigate its consequences.

When a transient occurs, it is the responsibility of the authorized operators (Shift Supervisor and Main Control Room Operator) to recognized situations that may cause OP&P or license violations and / or a threat to plant safety or to personnel. Crew response to transient is defined in station procedure “Transient Response Strategy”, and it is declared that the transient ends when the unit is in a known and stable state.

Abnormal Plant Operating Procedures (APOPs), provided for response to design basis accidents and design extension conditions, include event-based type of procedures, as well as symptom based procedures. Two new APOPs, for responding to Station Black-out and Abnormal Spent Fuel Bays Cooling Conditions, have been issued as part of the response to lessons learned from the Fukushima Daiichi accident.

The current set of APOPs for Cernavoda NPP includes the following:

- APOP-E01 - Dual Computer Failure;
- APOP-E02 - Loss Of Feedwater;
- APOP-E03 - Loss Of Instrument Air;
- APOP-E04 - Loss Of Service Water;
- APOP-E05 - Loss Of Class IV Power;
- APOP-E06 - Large LOCA (Loss of Coolant Accident);
- APOP-E07 - Small LOCA;
- APOP-E08 - Steam Generator Tubes Failure;
- APOP-E09 - Partial Loss Of Class IV Power;
- APOP-E10 - Very Low Suction Bay Level;
- APOP-G01 - Generic Heat Sink (MCR);
- APOP-G02 - SCA (Secondary Control Area) Operation;
- APOP-G03 - Station Black-Out;
- APOP G04 - Abnormal Spent Fuel Bays Cooling Conditions.
- APOP G05 – Loss of Shutdown Cooling

Cernavoda NPP has implemented a set of Severe Accident Management Guidelines (SAMGs), to cope with situations in which the response based on APOPs is ineffective and the accident conditions progress to severe core damage. The objectives of the SAMGs are:

- to terminate core damage progression;
- to maintain the capability of containment as long as possible;
- to minimize on-site and off-site releases.

The SAMGs for Cernavoda NPP have been developed based on the generic CANDU Owners Group (COG) SAMGs for a CANDU-600 type of plant. In developing the generic SAMGs, COG adopted the Westinghouse Owners Group (WOG) approach, with the necessary technical modifications suitable for implementation in CANDU plants, based on extensive CANDU specific severe accident analysis and research.

Preparation of plant-specific SAMGs was done by customization of the generic COG documentation package for Cernavoda NPP, removing extraneous information not applicable to the station, incorporating station-specific details and information and making any other adjustments required to address unique aspects of the plant design and/or operation.

A total number of 48 documents were prepared (SAGs – Severe Accident Guidelines, SCGs – Severe Challenge Guidelines, CAs – Computational Aids, SACRGs – Severe Accident Control Room Guidelines, SAEGs – Severe Accident Exit Guidelines, DCF – Diagnostic Flowchart, SCST – Severe Challenge Status Tree and their associated background documents). Also, 40 Enabling Instructions (EIs) were prepared in order to support the line-ups for each strategy presented in the above mentioned documents.

The interface between APOPs and SAMGs was established by introducing the severe accident entry conditions into the APOPs. The interface with the Emergency Plans was provided by making revisions to the existing EPP documentation, to reflect the new responsibilities and requirements arising from the implementation of the SAMGs. Also, all categories of plant personnel involved in the emergency response organization were trained for SAMG use, and drills are currently being incorporated in the overall Emergency Response Training Program.

The SAMGs have been developed based on the existing systems and equipment capabilities. A limited and focused set of information requirements was defined to support SAMG diagnostics and evaluations. The primary source is from plant instrumentation, supplemented by additional measurements and data expected to be available through emergency response procedures and Computational Aids where appropriate.

The list of SAGs (Severe Accident Guidelines) and SCGs (Severe Challenge Guidelines) is provided below:

- SAG-1 - Inject into Heat Transport System;
- SAG-2 - Control Moderator Conditions;
- SAG-3 - Control Calandria Vault Conditions;
- SAG-4 - Reduce Fission Product Release;
- SAG-5 - Control Containment Conditions;
- SAG-6 - Reduce Containment Hydrogen;
- SAG-7 - Inject into Containment;
- SCG-1 - Mitigate Fission Product Release;
- SCG-2 - Reduce Containment Pressure;
- SCG-3 - Control Containment Atmosphere Flammability;
- SCG-4 - Control Containment Vacuum.

The Emergency Response Operating Manual includes procedures to deal with the following type of emergencies:

- Radiological;
- Medical;
- Chemical;
- Fire;
- Extreme weather conditions;
- Spent fuel transfer/ transport incidents;
- Spent fuel bays and spent fuel dry storage facility incidents;
- Loss of Main Control Room.

This manual provides the necessary criteria to classify the emergency and easy access to each of the sections containing the necessary measures to be taken for the different types of emergencies. The overall process is governed by the on-site Emergency Plan.

19.5 Engineering and Technical Support

The station organizational chart for Cernavoda NPP documents the general areas of responsibility. The structure of the organization considers the needs for engineering and technical support and for this reason it includes strong Technical Unit covering the departments of Process Systems, Component Engineering and Design Engineering.

A strong link is also maintained with Romanian research institutes and with the designer of the plant, Atomic Energy of Canada Limited, Romania being member of CANDU Owners Group.

The Operations & Maintenance budget also contains provisions for the funding necessary to hire external institutes for services in the areas of research, design modifications, safety analyses, maintenance, inspections, etc.

The Technical Unit, through its dedicated departments, provide strong technical support through well-developed programs. The following sections provide information on the main activities of the individual Technical Unit Departments:

Process Systems Department:
The Process Systems Department fulfils its responsibility and accountability for the safe and reliable operation of assigned systems through well-developed programs such as System Health Monitoring (SHM) and other related processes implemented by Responsible System Engineers (RSEs). The System Engineer’s prime role is to plan and execute System Health Monitoring and performance assurance activities for assigned systems per the SHM program documents. The intent of their role is to have an overview for system performance in such a way so as to provide reasonable assurance that assigned systems will operate safely and perform in accordance with their design intent under normal and abnormal operating conditions.

The SHM program is governed by one Station Instruction and six Inter Departmental Procedures. Specifically, the following tasks are completed as part of the SHM program:

- Develop System Health Monitoring (SHM) plans, which define key parameters of assigned systems and equipment to be monitored, recorded, trended and analyzed at the specified frequency for addressing & mitigating any degradation in their performance;
- Develop system performance goals and monitor system performance against these goals according to the approved SHM plans;
- Monitor system specific equipment parameters and ensure they meet the acceptance criteria or have implement actions to address deficiencies;
- Execute system health monitoring activities including documented system walk downs, observation of system and equipment condition and transient analysis in accordance with the SHM Program;
- Prepare, issue and present System Health Monitoring reports to the SHM Review Board as scheduled;
- Prepare Action Plans to improve health of assigned systems.

Component Engineering Department:
The Component Engineering Department fulfils its responsibility and accountability for the safe and reliable operation of components and equipment through well-developed programs

such as Component & Program Health Monitoring Processes implemented by Component Engineers (CEs) and Program Engineers (PEs). The CEs/PEs prime role is to plan and execute Component and Program Health Monitoring Programs per the respective processes. They are expected to make sure that their assigned components and programs are effective to provide reasonable assurance that critical components will operate safely and perform in accordance with their design intent under normal and abnormal operating conditions.

The component and program health monitoring processes are governed by appropriate station process documents. Specifically, the following tasks are completed as part of these programs:

- Development and implementation of the Component Health Monitoring (CHM) program for assigned components and equipment;
- Development and implementation of long and short-term maintenance & inspection programs and monitoring of designated plant equipment and components to achieve this objective;
- Development and implementation of technical programs e.g. Piping Surveillance, Periodic Inspection Program (PIP), Supports/ Snubbers, etc.;
- Development and implementation of coordination programs e.g. Plant Life Management (PLiM), Preventive Maintenance (PM), Predictive Maintenance (PdM); Development and implementation of support programs e.g EQ, shelf Life, Leak Reduction, etc.

Design Engineering Department:
The Design Engineering Department fulfils its role by ensuring that design and configuration control activities under its responsibility are performed / verified using applicable codes, engineering standards, technical specifications, and safety analysis reports in accordance with the license conditions. Additionally, it is also assured through approved processes that plant design bases as well as the licensing bases are not affected by design modifications and that the design configuration control is maintained. The design processes ensure accuracy and completeness of work through review, verification and approval processes by qualified staff. It is expected that the design work done is free of errors and covers all aspects of design before it is considered ready for implementation.

The Design Engineers are expected to design, coordinate, manage, execute and document design modifications in accordance with the established and approved Design Change Policy process. Specifically, the following main tasks are completed as part of the design engineering functions:

- Perform design related activities for design modifications approved by Cernavoda Management Design Review and Approval Committee (DRAC);
- Coordinate and manage the Modification Proposals & Approval process.
- Perform all design related activities ensuring they meet applicable codes, standards, design specifications, safety analysis and operating license requirements;
- Develop design & support implementation of approved design modifications;
- Ensure upkeep of the station’s design configuration control, including the station design basis record;
- Perform procurement engineering related activities;
- Perform material / components equivalency assessments and substitutions as required.
- Establish and implement a process for liaising with the regulators on matters related to plant modifications.

19.6 Reporting of incidents significant to safety

The Operating License requires reporting of abnormal conditions/ events according to the station procedure "Events Reportable to CNCAN", which establishes the criteria and the method for reporting of events to CNCAN.

The document includes 47 criteria related to public safety, environmental protection, radiation protection, production, and security, and also events of interest to the regulatory (outside the scope of the reportable events). The procedure is kept updated by periodic revisions to address the current regulatory reporting requirements from updated regulations and to clarify the scope and intent of the reporting criteria regarding the impact of the event on the nuclear safety, in accordance with the latest international practices.

Operator's responsibilities during a transient include also notifying management. If the situation requires immediate notification to the Regulatory, as per guidance in the station procedure "Events Reportable to CNCAN", the on-call station manager will inform CNCAN as appropriate. Specific steps for communicating via telephone and fax are set with CNCAN, such as this communication to be effective whenever it is performed. A written notification will be made to CNCAN during the next working day.

The current process for reporting the abnormal conditions within Cernavoda NPP ensures that for any abnormal occurrence a report is issued immediately when the condition occurs or when it is acknowledged. Thus the report for the abnormal event will be issued immediately after stabilizing the situation and having the plant in a stable and safe state.

This report will be analyzed according to station procedure for "Abnormal Conditions Reporting", which means taking necessary steps for investigating, determining causes and taking adequate corrective actions to prevent recurrence.

At the end of investigations, when the corrective actions plan is approved by Management, a written Assessment Event Report will be submitted to CNCAN. This report will contain information related to the chronology of the event, significance to safety, causes and corrective actions taken by the plant to prevent recurrence.

Assessment Event Reports (AER) are prepared for those events that could have significant adverse impact on the safety of the environment, the public, the personnel, such as: serious process failures, failures of the special safety systems, trips of the shutdown systems, actuation of the ECCS or Containment system, violations of the OP&P/ license conditions, release of radioactive materials in excess of target, doses of radiation which exceed the regulatory limits, events which interfere with IAEA safeguards system, etc.

19.7 Operational Experience Feedback

For Cernavoda NPP the station goal with regard to operating experience is to ensure effective and efficient use of lessons learned, from own operating experience as well as from that of other plants, to improve plant safety and reliability.

Station events and human performance problems result from weaknesses or breakdowns in station processes, practices, procedures, training, and system or component design that were not previously recognized or corrected. This is the reason why Cernavoda NPP considers, as the main topic of the Operating Experience Program, the Event Analysis System, comprising identification, evaluation and analysis of operational events (both internal and external) in order to establish and implement corrective actions to avoid re-occurrence. The procedures that support the OPEX Program have been listed in the chapter corresponding to Article 10.

The basis for Operating Experience Program was set in place since the early stage of the commissioning phase of Unit 1, with the objective to ensure:

- the reporting, review and assessment of the station unplanned events and the establishment of the necessary corrective actions;
- information exchange within CANDU Owners Group (COG) and WANO, regarding abnormal conditions, technical problems, research and development projects, etc.

19.7.1 Internal operating experience

Classification of the abnormal conditions is based on their impact (actual or potential) on nuclear safety, personnel safety, environment or production. The detail of level investigation is based on the classification of the abnormal conditions, starting from registering trend analysis for the minor abnormal conditions, to systematic analysis of root causes for major impact events.

For each event investigated, previous similar conditions are taken into account and if an emerging trend is identified, the classification of the abnormal condition will be upgraded to reflect the significance of the condition because of the re-occurrence (i.e. even if an abnormal condition, considered as a singular occurrence, is deemed to be classified “minor”, it will be investigated as “important”, if a series of similar occurrences is identified).

According to the current station instruction “Abnormal Condition Reporting” (ACR), events that meet the investigation threshold established by this procedure are investigated using root cause analysis methodologies. A management sponsor (at management/senior superintendent level) for each root cause analysis event is responsible for establishing investigation scope and depth, and provide oversight of the investigation team. The investigation team is formed of specialists from all disciplines involved in the analysis of the event. Members of analysis team are responsible to provide technical support for all steps of investigation using root cause techniques.

Each stage of the investigation is required to be performed within a specific time frame. For instance, a root cause analysis will be performed within 20 working days from the occurrence of the event, an apparent cause investigation in 15 days and an evaluation (assignment of corrective actions at supervisory level) will be done in 10 days. These targets are assigned and followed using the computerized database for the event reports.

The process of event investigations and identification of corrective actions is standardized. Standard templates for Apparent Cause Evaluations, Root Cause Analysis Reports are available on the station intranet together with instructions for filling in the reports. The reports evaluate previous similar events and determine if previous corrective actions were effective, and also extent of condition/causes of the events is taken into account.

Apparent cause evaluations are reviewed by the Abnormal Condition Review Committee (ACRC). Proposed corrective actions, approved by ACRC are transferred into Action

Tracking for follow-up.

When a root cause analysis is finalized, and the proposed Action Plan is prepared, a Root Cause Analysis Review Committee (RCARC) meeting is arranged. The meeting is chaired by the Station Manager; RCARC approves the root cause analysis and the corresponding action plan. Proposed actions are then transferred into Action Tracking, and followed to completion.

The apparent cause evaluation reports, root cause analysis reports and other documents (TOE, ODM, etc.) are available in the station events database for further reference. Relevant OPEX information is brought to the attention of working groups via pre-job briefings and just-in-time training. If necessary, specific training and reinforcement actions are set for specific working groups, to discuss the lessons learned from these events. For most important events, like plant transients or serious human performance events, training materials and station information bulletins are issued, with emphasis on the most important aspects of the events.

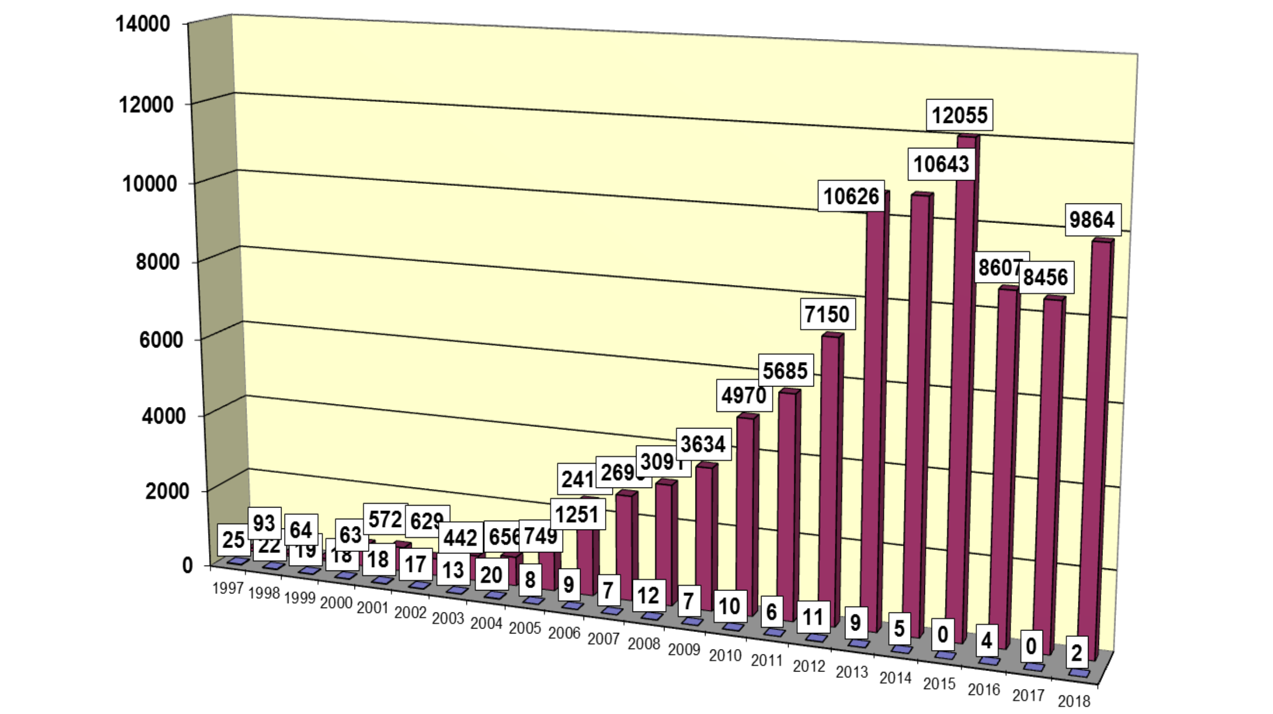
Starting with 2007, since the beginning of the commercial operation of Cernavoda Unit 2, the operating experience program at Cernavoda NPP comprises both Units, based on the same set of procedural guidance which was accordingly revised to reflect operation with two Units.

The number of abnormal condition reports (ACRs) initiated has been increasing, reaching around 10000 ACR per year in the last years. It is a management priority to reinforce the expectations for initiation of ACRs for all abnormal conditions encountered, especially low-level events which may represent precursors or near misses, and for any minor deficiency encountered in plant processes, work practices or human performance. The steady safety performance is demonstrated by the low number of reportable events,

In order to improve the quality of the event analysis process, a significant focus was placed on the training program for the plant personnel. The training courses envisaged the process of initiation of ACRs, the use of the computerized databases and of the operating experience websites. A large number of plant personnel were involved in the training programs. Another aspect followed through training courses is related to improving the quality of the apparent cause evaluations and root cause analyses. For this, a “Root cause analysis manual” was issued based on the common investigation techniques such as WANO Human Performance Enhancement System (HPES) and IAEA ASSET.

The OPEX database is maintained for internal/ external ACRs, for both Units. Corrective actions associated with the ACR are managed through WMS Action Tracking Module, as Action Requests / assignments.

A graph for the evolution of the number of Abnormal Condition Reports and the AERs showing the continuous trend for improvement is provided in Fig. 19.1.



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Reportable events	25	22	19	18	18	17	13	20	8	9	7	12	7	10	6	11	9	5	0	4	0	2
Total number of ACRs	93	64	63	572	629	442	656	749	1251	2411	2696	3091	3634	4970	5685	7150	10626	10643	12055	8607	8456	9864

Fig. 19.1 Trending of Abnormal Condition Reports and of Assessment Event Reports

Trending of the low-level events

The general interest in a "learning organization" is to report and record as many low-level events as possible. These are non-consequential events that highlight latent organizational weaknesses and increase the chances of error during the performance of a specific task by a particular individual.

Analyzing the trends of low level events allows identifying underlying organizational weaknesses that may generate events with significant impact. Identification of low-level events and understanding the common aspects that connect those events provides adequate justification to proactively establish new barriers (or strengthen old ones) in order to prevent future significant events.

The information regarding the abnormal conditions reports is maintained in a database that tracks all the related information. The events are coded against causal codes and other parameters that allow periodically trend analysis to show emerging trends and new issues. Coding of ACRs has been continually improved to provide for meaningful parameters and clear quantitative criteria for identification of an adverse trend.

The trend analyses are performed quarterly, or at station management request, and presented graphically, with comments and proposal for corrective actions. The Trend Analysis report contains all the analyses performed by the OPEX group, is verified and approved by the senior management (Safety, Compliance & Performance Improvement Senior

Superintendent, Station Manager) and is also discussed during periodic management meetings.

Adverse trends are subject of ACRs and they are analyzed in order to identify the common causes and to assign the corrective actions, the main purpose being to fix the adverse trend. Corrective actions efficiency review is done in the following trend analysis reports performed for the next quarters.

Trend analyses are also performed by the key departments using the ACR codes. The analyses are documented as Information Reports and are approved to the Senior Superintendent level. For any adverse trending identified, ACRs are issued and analyzed for common cause identification and corrective actions are assigned, addressing the causes.

The ACR screening process includes a daily screening meeting of the Abnormal Condition Review Committee to classify ACRs. This multidisciplinary screening also has accountability to immediately assess operability concerns and the need for compensatory actions.

19.7.2 External operating experience

The external information on operating experience proved to be a very important tool in improving station performance. Therefore, the second main topic of the operating experience program is the Information Exchange Program, with bi-directional use:

- collecting of external information and distribution to the appropriate station personnel;
- submitting the internal operating experience information to external organizations.

The station procedure "External Operating Experience Feedback" is in place for screening for applicability the information provided by external organizations like COG, WANO, INPO and IRS. For any applicable external event identified an external ACR is issued and recorded in OPEX database. External ACRs are analyzed using a specific template.

For the major events (e.g. WANO Significant Operating Experience Reports/Significant Event Reports, IRS events level 2 or higher on INES scale), an Abnormal Condition Report is issued, and the analysis is performed using a gap analysis template. This means that the station actual processes, procedures and work practices are compared with the recommendations given in the reports, a gap is identified between current situation and recommended aspects, and actions are defined to fill in the gap. Further processing is performed according to station instruction "Abnormal Conditions Reports".

Except this formal processing and tracking of significant industry events, plant personnel has access to the COG Operating Experience Database and to WANO/INPO websites and operating experience posts and monitors daily the new events posted on these websites. The majority of the records is posted only for information, but might be used while reviewing in-house events, design modifications or looking for relevant just-in-time operating experience for certain operational evolutions or other activities.

The international nuclear organizations require a prompt notification regarding events occurred at the station in order to offer well-timed information to the world community. For the information exchange program, a contact person, appointed by the station management, with the following general responsibilities maintains the relation between Cernavoda NPP and COG / WANO:

- serving as a liaison between COG / WANO and Cernavoda NPP;
- reviewing the incoming messages and distributing them to the appropriate plant personnel;
- ensuring the transmittal of the required information/reports to COG / WANO;
- ensuring optimum participation by the station personnel.

The criteria for reportable events to COG and WANO are defined by these organizations in reference documents. These criteria are:

- Severe or unusual plant transients;
- Malfunctions or improper operation of safety systems;
- Major equipment damage;
- Excessive radiation exposure or severe personnel injury;
- Unexpected or uncontrolled release of radioactivity in excess of off-site or on-site regulatory limits;
- Fuel handling or storage events;
- Deficiencies of design, analysis, fabrication, construction, installation, operation, configuration management, man-machine interface, testing, maintenance, procedure or training deficiencies;
- Other events involving plant safety, reliability or significant loss of production;
- Any other events of generic interest to CANDU NPPs.

Still, a number of events that do not meet these criteria but are considered of interest to the industry, representing various opportunities for improving work practices and procedures or finding about particular design or equipment flaws that could be corrected before they occur in site are reported. Thus, the reports shared with the industry might not reach the level of reporting, but still contain significant learning points.

Cernavoda NPP level of event reporting to the external organizations has continuously improved. The number of event reports to the external organizations is monitored at the station level and complies with the targets for reporting set by these external organizations. CNE Cernavoda has met the requirements imposed by WANO Atlanta Center for the number and timeliness of reports. Also, the number of external events which were formally reviewed through the ACR process has steadily increased, reaching 364 external ACRs in 2018. This results in a better utilization of the external information and a greater awareness of the plant personnel for the industry events.

At regulatory level, CNCAN is member of the International Reporting System (IRS), contributing to international experience exchange by reporting generic events or issues of interest for the nuclear community. All events reported to CNCAN by the Cernavoda NPP are independently assessed by CNCAN from two points of view: INES rating and analysis using a recognized methodology (ASSET, HPES) for direct and root causes determination as well as appropriateness of the corrective actions established by the license holder. The applicability of corrective actions resulted from nuclear events reported through IRS is also assessed, their implementation in Cernavoda NPP being surveyed by means of regulatory topical inspections.

Information obtained from the internal and external operational experience is used for multiple purposes, such as:

- improving the operating practices and plant staff training programs;
- improving the plant design;
- input for Ageing Management Program;
- assessment of necessity for updating of the safety analyses (deterministic and probabilistic), etc.

19.8 Management of Spent Fuel and Radioactive Waste

Minimization of waste

Waste minimization is considered in Romania as an important issue, having direct impact on radioactive waste management.

An important means for the reduction of the volume of radioactive waste generated is the clearance of the waste, incineration of the combustible radioactive waste and melting of the metallic radioactive waste. CNCAN has issued the “Requirements for clearance from licensing regime of materials resulted from licensed nuclear practices”. The above mentioned regulation establishes clearance levels, both for conditional and free release of materials from radiological areas.

Waste streams are defined and waste are collected and segregated depending on generation source and activity levels. Significant quantities of metallic, organic liquid and textiles (protective equipment) waste have been unconditionally released from CNCAN control, the clearance process being an important way to minimize waste volumes.

Also, the ALARA policy is applied for material management during preparation and executing radiological activities inside of radiological areas, in order to minimized radioactive waste produced

The main objectives of waste management program at Cernavoda NPP are:
- Complete waste identification and control by corresponding work procedures;
- Maintaining of waste production as low as possible.

Control measurements applied during plant operation and maintenance activities consist in the following:
- Waste production minimization
- Equipment reutilization as per initial destination;
- Materials recycling;
- Materials clearance from licensing regime;
- Waste treatment methods specific to waste stream characteristics;

Waste production is minimized as volumes and activities, by:
- proper operation and maintenance procedures both for primary and secondary waste..
- Volume reduction by controlling the types and quantities of materials entering radiological areas;
- Thorough waste characterization procedures from physical, chemical and radiological point of view;
- Activities planning and using corresponding waste handling equipment; in order to avoid secondary waste production;
- Equipment surfaces decontamination to avoid contamination spreading;

Radioactive waste conditioning technologies are selected in order to minimize the volume of temporary stored waste, for example solidification of organic liquid using high capacity absorbents. This requirement is considered by CNCAN in the licensing process.

Generation of radioactive waste associated with CANDU spent fuel is minimized through:
- the quality of fuel;
- timely detection and removal of the failed fuel,
- canning of the failed fuel.

Good fuel management resulted in significant reduction or radioactive waste generated by loss of fission and activation products from faulty fuel bundles. Also the volume of purification filters (spent resins) is maintained at relatively low values.

For all spent fuel, the control of water parameters in wet storages, and control of confinement and of the isolating air parameters for dry storage minimizes the generation of radioactive waste associated with spent fuel management.

The tritium removal facility project (mentioned under Article 15) reached conceptual design completion and agreement of licensing basis with the Regulatory Body. The implementation of the project (currently under approval) will result in decreasing the tritium concentration in the moderator circuit and will contribute to significant reduction of tritium contaminated waste.

Control of treatment and interim storage of radioactive waste

The solid radioactive waste is pre-treated and treated into stainless steel drums. The waste is then temporarily stored into interim storage pending recovery, conditioning and disposal.

Programs to manage radioactive waste

Cernavoda NPP has all operational arrangements including special designated facilities for proper current management of its gaseous, liquid and solid operational radioactive wastes, in order to assure the protection of the workers, the public and the environment.

The gaseous wastes are collected by ventilation systems, filtered and released through the ventilation stack under a strict control to minimize the environmental impact. The aqueous liquid wastes of NPP are collected and after adequate purification by using ion exchange resins (if necessary), are discharged into the environment.

The aqueous liquid waste having higher gamma radioactivity which prevent releasing through plant system are send to a decontamination facility outside Cernavoda NPP in order to retain gamma contaminants.

Minimizing the volume of radioactive waste by using treatment/ conditioning and clearance

At Cernavoda NPP, the produced radioactive waste volumes are continuously diminished through clearance, incineration and melting methods.

The clearance process performed at Cernavoda NPP were approved by regulatory body for specific types and quantities of waste. In accordance with the licenses for each unit, Cernavoda NPP is authorized to unconditionally clear 100 tons of waste and materials yearly from each unit based on approved procedures. Clearance process has been started in 2008 by releasing a number of 77 drums x 0.22 m^3 of spent oils produced from various plant systems, the major route of contamination being represented by contact with the reactor primary coolant.

In the following years, the process continued by releasing solid radioactive waste such as:
- metallic waste consisting mainly in crane components replaced from both units (approx. 5 tons in 2012, 5 tons in 2013);
- metallic waste consisting mainly in aluminum covers from ventilation filters units replaced from both units and from spend MSA tritium filters cartridges (aprox. 6 tons in 2014);
- textiles waste consisting in used radiation protection equipment (brown coveralls) (360 kg in 2014 and 3360 kg in 2015);
- metallic waste consisting in carbon steel drums for heavy water storage: 5591 kg (6.38 m^3) in 2016;
- metallic waste consisting in various metallic components consisted in aluminum covers from spent MSA tritium filters cartridges, carbon steel heavy water drums and various dismantled metallic components, 6651 kg (8.58 m^3) in 2017.
- metallic waste consisting in various metallic components consisted in cranes components, aluminum covers from spent MSA tritium filters cartridges and various dismantled metallic components 5370 kg (12.1 m^3), spend oils 330.6 kg (0.66 m^3) and spend batteries 440,5 kg (1 m^3) in 2018.

Waste treatment by incineration and melting is performed by sending the combustible waste for incineration to two licensed external operators, at Cyclife in Sweden and at Belgoprocess in Belgium and metallic waste is sent to an external operator Cyclife in Sweden for melting. About 137,000 Kg (398 m^3) radioactive waste have been submitted to an external operator for incineration and melting, thus obtaining a reduction in the volume of waste stored in the solid radioactive storage on site.

Spent ion resins are collected and stored into special tanks. The organic liquid waste is solidified in polymeric absorbent structure and stored on site, the arising of the secondary waste streams being taken into account from the treatment and conditioning of the radioactive waste.

Management of spent fuel

The spent fuel system of Cernavoda NPP Units 1 and 2 were designed to meet adequate safety standards as used in Canada. The Spent Fuel Bay of Cernavoda NPP – Unit 2 design meets the general requirements as described in the IAEA Safety Series 116 – Design of spent fuel storage facilities by including the following:
- measures to limit radioactive releases and radioactive exposures of workers and the public (including detection of leakage through the bay walls and floor);
- measures to prevent anticipated operational occurrences and accident conditions from developing into unacceptable severe accident conditions;
- provision for ease of operation and maintenance of essential equipment;
- provisions, through equipment and procedures, for retrieving spent fuel from storage.

After 6 years of storage in the Spent Fuel Bay, the spent fuel is transferred to the Spent Fuel Dry Storage. The Spent Fuel Dry Storage Facility is located on the NPP site, close to the containment building of Unit 5. Its designed storage capacity will be expanded gradually from 12,000 to 324,000 spent fuel bundles. It can accommodate the spent fuel inventory from two reactors. The dry storage technology is based on the MACSTOR System. It consists of storage modules located outdoors in the storage site, and equipment operated at the spent fuel storage bay for preparing the spent fuel for dry storage. The spent fuel is transferred from the preparation area to the storage site in a transfer flask. The transportation is on-site. Currently 9 storage modules are operational providing a total storage capacity of 108,000 spent fuel bundles.

Currently, a new strategy for the future development of the Dry Spent Fuel Storage has been approved, the main 2 major changes being the future use of double capacity MACSTOR 400 modules instead of actual MACSTOR 200 as well as the increase of the storage area, to take into account Units 1 and 2 refurbishment and long term operation. Based on this revised strategy, a better use of the existing storage area and adequate storage capacity for the planned long term operation of Units 1 and 2 will be achieved.

19.9 Significant developments for the last reporting period

The developments of the regulatory framework, with new requirements applicable to the operating phase, have been reported in the Chapter corresponding to Article 7.

All the procedures for responding to anticipated operational occurrences and accidents have been systematically reviewed and revalidated during the period 2017 – 2018. The revalidation confirmed the adequacy of the procedures and allowed for the identification and subsequent implementation of improvements in the logistics of the response to abnormal events.

Regarding the use of operational experience feedback, the trend of abnormal conditions reported for the two Cernavoda units shows a built-up of a culture for reporting abnormal conditions at all levels.

The improvements in human performance in operations have been reported in the chapter corresponding to Article 12.

The main improvement in radioactive waste management program at Cernavoda NPP for the last reporting period was the reduction of the volume of generated radioactive waste by clearance and incineration of the combustible radioactive waste.

LIST OF ACRONYMS

ACR - Abnormal Condition Report

ALARA - As Low As Reasonable Achievable

ANCEX - National Agency for the Control of Exports

ANCST - National Agency for Research and Technology

ANDR - Nuclear Agency and for Radioactive Waste Management

APOP - Abnormal Plant Operating Procedure

BE - Basic Events

BOP - Balance of Plant

CANDU - Canadian Deuterium Uranium Reactor

CBT - Computer Based Training

CNCAN - National Commission for Nuclear Activities Control

CNU - National Uranium Company

COG - CANDU Owners Group

CPR - Centre for Radio-Isotopes Production

CRO - Control Room Operator

CSRG - CANDU Senior Regulators' Group

IFIN – HH - R&D Institute for Physics and Nuclear Engineering "Horia Hulubei"

IR - Information Report

ISCIR - State Inspectorate for Boilers, Pressure Vessels and Hoisting Installations

JRTR - Job Related Training Requirements

DCC - Digital Control Computers

DEL - Derived Emission Limit

DM - Design Manual

DNDR - National Repository of Radioactive Waste

EBP – Extra Budgetary Program

ECCS – Emergency Core Cooling System

EFD - Event Free Days

EFT - Event Free Tools

ENSREG – European Nuclear Safety Regulators Group

EOOS - Equipment Out Of Service

EPRI - Electric Power Research Institute

GEM - Gaseous Effluents Monitor

HP - Human Performance

IAEA - International Atomic Energy Agency

ICSI - Institute for Cryogenics and Isotopes Separation

ICRP - International Committee for Radiation Protection

IDP – Inter-Departmental Procedure

IGSU - General Inspectorate for Emergencies

INPO - Institute of Nuclear Power Operations

IPSART - International Probabilistic Safety Assessment Review Team

IR – Information Report

ISO - International Organization for Standardization

LEM - Liquid Effluents Monitor

LEPI - Post-Irradiation Examination Laboratory

LSC - Liquid Scintillation Counting

MCR - Main Control Room

MPA - Modification Proposal and Approval

NMC - Norms on Quality Management

NPP - Nuclear Power Plant

NSP - Nuclear Steam Plant

ODM - Operational Decision Making

OJT - On-the-Job Training

OLC - Operational Limits and Conditions

OM - Operating Manual

OMT - Operating Manual Tests

OPEX - Operating Experience

OP&P - Operating Policies and Principles

OSART - Operational Safety Review Team

PHWR - Pressurized Heavy Water Reactor

PJB - Pre-Job Briefing

PSA - Probabilistic Safety Assessment

PSOC - Plant Safety Oversight Committee

PSP - Process Specific Procedures

PSR – Periodic Safety Review

QMS - Quality Management System

QTR - Quarterly Technical Report

RCA - Root Cause Analysis

RD - Reference Document

RSE - Responsible System Engineer

RSP - Regulatory Surveillance Plan

SADL - Safety Analysis Data List

SAMG - Severe Accident Management Guidelines

SCA - Secondary Control Area

SDG - Safety Design Guide

SDM - Safety Design Matrix

SER - Significant Event Report

SI - Station Instruction

SITON - Centre for Nuclear Projects Engineering

SNN - National Company “NUCLEARELECTRICA”

SOER - Significant Operating Experience Report

SOS - Standard Operating Sequence

SS - Shift Supervisor

SSC - Systems Structures and Components

TLD - Thermo Luminescent Dosimeter

TOE - Technical Operability Evaluation

WANO - World Association of Nuclear Operators

WENRA - Western European Nuclear Regulators Association

ANNEX 1

Structure and content of the Law 111/1996 on the safe deployment, regulation, licensing and control of nuclear activities

The purpose of the Law is to provide for a comprehensive legal framework for the regulation, licensing and control of all activities related to the peaceful use of nuclear energy. The content of the Law is described as follows:

Chapter I - General Dispositions

This chapter defines the purpose of the law, the activities which are within the scope of the law, as well as the authority, mandate and responsibilities of CNCAN.

The Law applies to the following activities and sources:

- research, design, possession, siting, construction, assembly, commissioning, trial operation, operation, modification, preservation, decommissioning, import and export of nuclear installations;
- design, possession, siting, construction, assembly, commissioning, operation, preservation and decommissioning of installations for milling and processing of uranium and thorium ores and of installations for the management of wastes resulted from the milling and processing of uranium and thorium ores;
- production, siting and construction, supply, leasing, transfer, handling, possession, processing, treatment, use, temporary or permanent storage, transport, transit, import and export of radiological installations, nuclear and radioactive materials, including nuclear fuel, radioactive waste, and ionizing radiation generating devices;
- production, supply, and use of dosimetric equipment and ionizing radiation detection systems, materials and devices used for the protection against ionizing radiation, as well as containerization or means of transport for radioactive materials, especially designed for such purposes;
- production, supply, leasing, transfer, possession, export, import of the materials, devices, and equipment specified in Annex 1 to the Law;
- possession, transfer, import and export of unpublished information related to materials, devices and equipment pertinent to the proliferation of nuclear weapons or other explosive nuclear devices, as specified in Annex 1 to the Law;
- manufacturing of products and supply of services designed for nuclear installations;
- manufacturing of products and supply of services designed for radiation sources, dosimetric control instruments, ionizing radiation detection systems, materials and devices used for the protection against ionizing radiation.
- orphan sources, from their detection to their final disposal as radioactive waste.

In accordance with the Law, CNCAN is the national competent authority that exercises regulation, licensing and control attributions in the nuclear field. CNCAN is a public institution of national interest, with legal personality, having its headquarters in Bucharest, chaired by a President with the rank of State Secretary, coordinated by the Prime Minister through the Prime Minister's Chancellery. The first chapter of the Law also establishes the modality of CNCAN financing.

The general dispositions also include statements with regard to the banning of nuclear proliferation activities and import of radioactive waste and spent fuel (unless the waste and spent fuel originates from Romania).

Chapter II - Licensing Regime

This chapter is structured in two sections: "Licenses and Permits", and "Licensing Conditions."

The first section defines all the activities for which a formal authorization from CNCAN is needed, under the form of a license or permit. It also set the general framework for the licensing process, including the licensing stages for the nuclear installations.

The licenses for nuclear installations are granted to legal persons, at their request, if they prove compliance with the provisions of the Law and specific regulations issued by CNCAN. According to the Law, the licenses issued by the CNCAN shall be drawn up by levels of exigency, depending on the risks associated with the activities that are subject to licensing.

The licenses are applied for and issued, respectively, either simultaneously or successively, separately for each kind of activity or for each nuclear or radiological installation operating independently, belonging to the applicant's property. The licensing of construction or operation phases for any nuclear or radiological facility may only take place if for the previous phases have been granted all the types of necessary licenses.

For a nuclear installation such as a nuclear power plant, the licensing stages include design, siting, construction, commissioning, trial operation, operation, repair and/or maintenance (as major refurbishment), modification (as major upgrades), preservation and decommissioning.

Partial licenses may also be issued to cover the construction or operation stages of nuclear and radiological facilities. Partial licenses issued simultaneously or successively for one and the same stage may have the character of a provisional decision of CNCAN, if the applicant expressly requests so. In such a case their validity shall extend up to the issuing of the final license of that type, but no more than two years with an extension right, on request, for two more years, when all necessary information is not available in due time. The partial license can be withdrawn by CNCAN whenever it finds a lack of concern on the part of the license holder for the completion of the necessary information in support of the application.

The licenses and the permits are granted for a period established in accordance with the regulations developed by CNCAN. The licenses and permits are not transferable.

Apart from situations when the license holder is no more legally constituted or loses the legal personality, the licenses can be suspended or withdrawn, partially or in total, for all cases of:

- non-compliance with the legal and regulatory provisions, or with the limits and conditions of the license;

- failure to implement the corrective actions dispositioned as a result of the regulatory control;

  new situations, from technical point of view, or of other nature, that had been not known prior to the issue of the license, and which could impact upon the safe deployment of the licensed activities.

The practice permits can be suspended or withdrawn for all cases of non-compliance with the provisions of the applicable regulations.

The second section of Chapter II provides the general conditions that an applicant shall meet for obtaining a license, such as:

- to demonstrate the provision of adequate resources for carrying out the activities in a safe manner;
- to take all the necessary measures, at the level of the current technological and scientific standards, to prevent the occurrence of any damage that may result due to the construction and operation of the nuclear installation;
- to prove that has organizational capacity and responsibility in preventing and limiting the consequences of failures having the potential for a negative impact on the life and health of his own personnel, on the population, on the environment, on the property of third parties or on his own assets;
- to have arranged indemnification for liability in case of nuclear damage;
- to ensure that the decision-making process for safety matters in not unduly influenced by third parties;
- to have established arrangements, in accordance with the provisions of the specific CNCAN regulations, for ensuring radiological safety, physical protection, quality management, on-site emergency preparedness;
- to have established a system for the information of the public.
- to prove that has adequate and sufficient material and financial arrangements for the collection, transport, treatment, conditioning and storage of radioactive waste generated from the licensed activities, as well as for the decommissioning of the nuclear installation upon termination of operations, and has paid the contribution for the establishment of the fund for the management of radioactive waste and decommissioning;
- to prove that has obtained all the other licenses, agreements, approvals in accordance with the legislation in force, that are prerequisites for the license issued by CNCAN.

Further information on the general conditions regarding the assurance of sufficient financial and human resources is provided under Article 11, while the conditions for obtaining a license for the quality management system are described under Article 13.

Chapter III - Obligations of the License Holder

This chapter establishes the general obligations of the license holders and responsibilities for the safety of their licensed installations, including nuclear waste management and decommissioning. Relevant excerpts from the Law are provided in this report under Article 9 of this report.

Chapter IV - Control Regime

The legal provisions stated in this chapter empower CNCAN to carry out inspections at the license holders as well as at the applicants for a license, to control the application of the relevant regulatory requirements.

CNCAN inspectors are empowered to perform the necessary control activities at the site where the activities subject to licensing are deployed, as well as at any other location which may be connected to these activities, including the home or other location of any natural or legal person that may carry out activities related to nuclear and radiological installations or have possession of any nuclear or radiological materials, including related information.

The control activities are performed for any of the following situations:

- before granting the license for which an application has been submitted;
- for the whole period of validity of the license (periodic, as well as unscheduled or unannounced inspections);
- based on a notification/request made by the license holder;
- for cases when it is suspected that installations, devices, materials, information, activities, etc., that are under the scope of the Law, exist or are performed without having been registered and subjected to licensing/authorization process.

Following the control, CNCAN may disposition, if deemed necessary, the suspension of the activities and cease of operation/use of the respective installation, materials, devices, equipment, information, etc. that are possessed/operated/used without a license or the operation/possession of which could pose a threat.

In exercising the control mandate, CNCAN representatives are empowered to:

a) access any place in which activities subject to the control may be deployed;
b) carry out measurements and install the necessary surveillance equipment;
c) request the taking or receiving of samples from the materials or products directly or indirectly subject to the control;
d) compel the controlled natural or legal person to ensure the fulfilment of the provisions mentioned under points a) – c) and to mediate the extension of the control to the suppliers of products and services or to their subcontractors;
e) have access to all the information necessary for achieving the objectives of the control, including technical and contractual data, in any form, with observance of confidentiality if the holder makes explicit requests in this sense;
f) compel the license holder to transmit reports, information, and notifications in the form required by regulations;
g) compel the license holder to keep records, in the form required by regulations, of materials, of other sources and activities subject to the control, and to control these records;
h) receive the necessary protective equipment, for which the applicant or license holder shall arrange.

For the whole duration of the control activities, CNCAN representatives have the obligation of observing the applicable licensing conditions, as imposed upon the personnel of the license holder.

CNCAN representatives have the following attributions, to be exercised after conclusion of the inspection/control activity:

a) to draw up a report stating the results of the control, the corrective actions requested, and the deadlines for their implementation;
b) to propose the suspension or withdrawal of the license or practice permit, under the terms of the Law;
c) to propose the information of the legal prosecution bodies in the cases and for the violations specified under the Law;
d) to request that the license holder to applies disciplinary sanctions to the personnel guilty of violations specified in the Law;
e) to apply the sanctions for contraventions, as specified in the Law, to the persons vested with the statutory responsibility of representing the license holder in the relation with the public authorities;
f) to apply the sanctions for contraventions, under the terms of the Law, to the personnel guilty of commission of the respective violations.

Chapter V - Attributions and Responsibilities

This chapter defines the attributions and responsibilities of CNCAN, as well as those of the other governmental organizations that have different roles in the regulation, monitoring or control of the various nuclear activities. The provisions stated in Chapter V of the Law are described in this report under Article 8.

Chapter VI - Penalties

This chapter defines the violations, including criminal offences, acts of terrorism and contraventions, and the respective penalties entailed, specifying that the offences of attempt are also subject to prosecution. The unauthorized deployment of any of the activities subject to licensing or approval under the terms of the Law constitutes a criminal offence.

Chapter VII - Provisional and Final Dispositions

This chapter includes provisions with regard to the validity of the licenses and permits issued prior to the coming into force of the Law, the possibility of appealing against any regulatory decision claimed to have caused a prejudice, etc.

The Annexes to the Law include the following:

Annex 1: List of materials, devices and equipment pertinent to nuclear proliferation;

Annex 2: Definitions;

Annex 3: Authorities having various attributions in the review and inspection of nuclear activities:

1. CNCAN;
2. Local Authorities for Public Health;
3. State Inspectorate for Environmental Protection;
4. State Inspectorate for Boilers, Pressure Vessels and Hoisting Installations (ISCIR);
5. The National Committee for Emergency Situations;
6. General Police Inspectorate;

7. State Inspectorate for Labour;
8. National Agency for the Control of Exports;
9. National Authority for Customs;
10. The Romanian Bureau of Legal Metrology.

Annex 4: List of organizations without legal personality, which can hold a license under the terms of the Law.

ANNEX 2

Romanian Action Plan post-Fukushima - Summary of improvement activities

The latest status of the Romanian National Action Plan is summarized in the table below, which provides an outline of the main improvement activities resulting from the post-Fukushima safety reviews performed to date. The table identifies, for each action, the organization(s) responsible for implementation (SNN - the licensee, CNCAN, or both), the status of the action (implemented, in progress, planned or under evaluation) and the target date for completion. The status of the actions reflects the situation as of August 2019.

CNCAN monitors the licensee's progress in the implementation of the planned improvements and continues to perform safety reviews and inspections to ensure that all the opportunities for improvement are properly addressed taking account of the lessons learned from the Fukushima accident.

Action	Responsible for implementation	Status	Target date for implementation
Topic 1 – External events (earthquakes, floods and extreme weather conditions)			
1. Review the specific procedure which is in place for extreme weather conditions in order to include the appropriate proactive actions for plant shutdown.	SNN	Implemented	-
2. Identification of potential measures to improve protection against flooding.	SNN	Implemented	-
3. Provision of on-site of sand bags to be used as temporary flood barriers, if required.	SNN	Implemented	-
4. Improvement of the seismic robustness of the existing Class I and II batteries.	SNN	Implemented	-

Action	Responsible for implementation	Status	Target date for implementation
5. Design modifications to replace selected doors with flood resistant doors and penetrations sealing (for improving the volumetric protection of the buildings containing safety related equipment located in rooms below plant platform level).	SNN	In progress	July 2020 The target date for implementation was initially the end of 2014. All identified flood resistant doors (around 50) were installed in Unit 1 and Unit 2. All design changes identified in rev. 0 of the MPA#1094 (flood doors and penetration sealing) are implemented. Still in progress are the activities to improve penetrations sealing of selected T/B rooms as per rev. 2 of MPA#1094. The change of the target date for implementation was due to the complexity of the engineering solutions for penetrations' sealing. The remaining activities are introduced in the Work Management System and are monitored.
6. The seismic walk-downs and subsequent seismic robustness analyses done as part of the seismic margin assessment have not revealed a need for any safety significant design change. However, several recommendations resulted from these inspections, which have been included in the regular plant seismic housekeeping program. These do not impact on the seismic margin assessment.	SNN	Implemented	-
7. The regulator to consider routine inspections of the flood protection design features.	CNCAN	Implemented	-

Action	Responsible for implementation	Status	Target date for implementation
8. The peer review recommended that a seismic level comparable to the SL-1 of IAEA leading to plant shutdown and inspection is established. It was suggested to the regulator to consider implementing adequate regulations. Currently the actions taken by the licensee following an earthquake are based on decision making criteria that include the estimated damage to the plant (walkdowns using a specific procedure) rather than on pre-defined level.	CNCAN	Implemented	Cernavoda NPP has established the SL-1 level. The regulation NSN-06 on the protection of nuclear installations against external events of natural origin has been published in January 2015.
9. Elaboration of more detailed regulatory requirements on the protection of NPPs against extreme external events, taking account of the lessons learned from the Fukushima accident and of the results of the "stress tests" peer reviews.	CNCAN	Implemented	The regulation NSN-06 on the protection of nuclear installations against external events of natural origin has been published in January 2015.
10. The peer review concluded that there is only little information about margins to cliff edges due to external events and weak points. Further work is proposed in this area and it is recommended that CNCAN obtains good quality programs from licensees and ensures that the work is appropriately followed up.	CNCAN	Implemented	The regulation of NSN-06 includes requirements on the assessment of cliff-edge effects due to external events of natural events. Based on the assessments implemented so far, it was concluded that the existing safety margins are sufficient to prevent cliff-edge effects.

Action	Responsible for implementation	Status	Target date for implementation
Topic 2 – Design Issues			
11. Procurement and testing of mobile equipment (e.g. mobile diesel generators, mobile pumps, connections, etc.).	SNN	Implemented	-
12. Provision of a facility to open the MSSVs after a SBO.	SNN	Implemented	-
13. Provision of connection facilities required to add water using fire fighters trucks and flexible conduits to supply the primary side of the RSW/RCW heat exchangers and SGs under emergency conditions.	SNN	Implemented	-
14. Specific emergency operating procedures to cope with Station Blackout and Loss of Spent Fuel Pool Cooling events.	SNN	Implemented	-
15. The option of charging the batteries or the installation of a supplementary uninterruptible power supply for the SCA is being considered by the licensee as a potential improvement.	SNN	Implemented	A few options to supply plants critical parameters from SCA, during severe accident (SBO), from a seismically qualified power supply, were analyzed and documented. These options are in addition to existing modification for supplying SCA panels from the large mobile Diesel generators, which is implemented. The solution selected for implementation, documented in MPA#EC1973, was to add a new power supply to SCA instrumentation panels from 100 kV mobile Diesels, which are already procured. The design modification package (MWP) also included new, seismically qualified, electrical panels that needed to be installed.

Action	Responsible for implementation	Status	Target date for implementation
Topic 3 – Severe Accident Management and Recovery (On-Site)			
16. Validation of the station Severe Accident Management Guidelines (SAMG) through emergency exercises.	SNN	Implemented	-
17. Training for severe accident scenarios, including as part of the emergency drills.	SNN	Implemented (Refreshment training is performed periodically)	-
18. Special agreements were established with the local and national authorities involved in the emergency response in order to ensure that in case of a SBO coincident with loss of primary UHS the plant has absolute priority to grid re-connection and supply of light and heavy equipment and the necessary diesel fuel.	SNN	Implemented	-
19. Accident management provisions for events in the spent fuel pools (natural ventilation for vapours and steam evacuation, seismically qualified fire-water pipe for water make-up).	SNN	Implemented	-
20. Improvement of the existing provisions to facilitate operator actions to prevent a severe accident in SFB (water level and temperature monitoring from outside the SFB building).	SNN	Implemented	Design improvements have been implemented at both units. Water level gauges were installed to allow operators SFB level measurement in case of severe accident from an accessible location, outside the SFB building. Portable devices will be used for water temperature measurement.

Action	Responsible for implementation	Status	Target date for implementation
21. Installation of PARs for hydrogen management.	SNN	Implemented	-
22. Installation of dedicated emergency containment filtered venting system for each NPP unit.	SNN	Implemented	-
23. Additional instrumentation for SA management e.g. hydrogen concentration monitoring in different areas of the reactor building.	SNN	Implemented	-
24. Improvements to the reliability of existing instrumentation by qualification to SA conditions and extension of the measurement domain.	SNN	Implemented	The design changes implemented at both Cernavoda Units to improve survivability to SA addressed the following parameters: - R/B pressure, - Calandria Vault level, - moderator level, - Heat Transport temperature.
25. Implementation of a design modification for water make-up to the calandria vessel and the calandria vault	SNN	Implemented	-
26. Verification of the completeness of event-based and symptom-based EOPs for all accident situations.	SNN CNCAN	Implemented	-
27. Severe accident management requirements to be included in a regulation.	CNCAN	Implemented	The regulation with requirements on severe accident management was issued in January 2014.

Action	Responsible for implementation	Status	Target date for implementation
28. MCR habitability analysis to be continued (e.g. assessment of total core melt with voluntary venting, implementation of close ventilation circuit with oxygen supply).	SNN	Implemented	-
29. Review of Level 1 PSA & completion of Level 2 PSA (to include SFB accidents).	SNN	Implemented	-
30. Measures have been identified (and will be implemented) that aim to improve the reliability of the: (i) communication system and (ii) on-site emergency control centre.	SNN	Implemented	-
31. Cernavoda NPP will establish a new seismically qualified location for the on-site emergency control centre and the fire fighters. This location will include important intervention equipment (mobile DGs, mobile diesel engine pumps, fire-fighter engines, radiological emergency vehicles, heavy equipment to unblock roads, etc.) and will be protected against all external hazards.	SNN	In progress	End of 2020 The target date was initially set for the end of 2015. It was changed due to legal and administrative issues related to transfer of property of the physical location. Until the completion of this action, equivalent measures have been implemented to ensure that all intervention equipment (mobile Diesels, Diesel fire pump, fire trucks, and so) are protected from external hazards (e.g. the equipment have been relocated so that they would not be impaired by external events).
32. Review of SAMGs taking account of plant modifications and upgrades performed after Fukushima.	SNN CNCAN	Implemented	-
33. The development of SAMGs specifically for shutdown states is under consideration.	SNN	Implemented	-

Action	Responsible for implementation	Status	Target date for implementation
Topic 4 – National Organizations			
34. Improvement of on-site emergency organization.	SNN	Implemented	-
35. Review of lessons learned from the Fukushima accident with regard to organizational factors and applicability to national organizations in the nuclear sector.	CNCAN SNN	Implemented	-
36. Implementation of recommendations from the 2011 IRRS mission.	CNCAN	Implemented	The recommendations from the 2011 IRRS mission with regard to regulation and oversight of nuclear installations have been implemented. New recommendations and suggestions have been issued by the follow-up mission received by CNCAN in October 2017.
37. Review of the national regulatory framework for nuclear safety to identify and implement actions for improvement.	CNCAN	Implemented	All the main regulations relevant for nuclear safety and emergency preparedness and response have been revised. Nevertheless the improvement of the regulatory framework is considered a continuous activity.
Topic 5 – Emergency Preparedness and Response and Post-Accident Management (Off-Site)			
38. Review the existing protocol with Public Authorities in order to ensure the necessary support for the Cernavoda NPP personnel in case of severe accident, when the roads are blocked due to extreme meteorological conditions, natural disasters (earthquakes, flooding, etc.) or other traffic restrictions.	SNN	Implemented	-

Action	Responsible for implementation	Status	Target date for implementation
39. Installation of Special Communication Service phones in each Main Control Room (Intervention Support Centre) and Secondary Control Area.	SNN	Implemented	-
40. An alternative off-site emergency control centre is being developed.	SNN	Implemented	The new offsite emergency control center was tested during a drill, in December 2015.
41. A review of the national off-site response is in progress to take account of the lessons learned from the Fukushima accident.	CNCAN + other national authorities	Implemented	The regulations and the national plan for emergency preparedness and response have been revised.
Topic 6 – International Cooperation			
42. Identification and consideration of additional relevant peer-review services.	CNCAN SNN	Implemented	This is a continuous activity, controlled by the OPEX processes. WANO-PEER Review Missions at Cernavoda NPP, from October 2013 and November 2015, had a specific section to evaluate the actions taken in response to Fukushima event. A specific Benchmarking on the subject of Emergency Preparedness was carried out in the week of 23-27.11.2015, at Pickering (OPG). OSART and IRRS missions are planned for 2016.
43. Participation in international activities for sharing experience on lessons learned from the Fukushima accident and on actions taken to improve safety.	CNCAN SNN	Implemented	Both CNCAN and the licensee have participated and continue to participate in all relevant international activities.