9. NON-TECHNICAL SUMMARY

9.1. General Data

Cernavoda NPP Units 3 and 4 belong to the Nuclearelectrica National Society (SNN) having its headquarters in Bucharest, Polona Street, no. 65, District 1, as the Project Owner and Beneficiary (Ref. 1-4, 1-5).

Designer of the works: design and engineering management consortium (traditional participants: AECL-Canada, ANSALDO-Italy, SITON-Romania).

The environmental impact assessment was carried out by ICIM on the basis of the documentation provided by SITON (description of the project and the Units 3 and 4 completion activities, radiological impact, risk situations analysis) and other analyses and reports, including specialized studies. ICIM is certified by the Ministry of Environment and Waters Management for performing Environmental Impact Assessment Studies and Environmental Assessments for all the activity domains.

ICIM has carried out monitoring activities continuously (since 1985) for the International Commission for the Protection of the Danube River (ICPDR).

Beginning from 1994, ICIM prepared many documentations for Cernavoda NPP, necessary for the authorization of its activities by the environmental protection authorities.

9.2. Brief Description of the Project

Activities

Units 3 and 4 are partially built and will be completed in the Cernavoda NPP site area. This site is located at 160 km east from Bucharest and is situated in the Constanta county. The Cernavoda NPP site was arranged according to the plan elaborated for this area, taking into account all the aspects related to the specific activities of the Cernavoda Nuclear Power Plant and its auxiliary installations.

The Cernavoda NPP was designed to operate with 5 Units of CANDU type of 700 MWe each.

Units 3 and 4 will have the Unit 2 design as a reference design in respect of the design solutions and will include possible feasible improvements applied to similar NPP units. The latest editions of the design standards, quality assurance and nuclear safety standards will be adopted.

It is estimated that the civil work finalization degree for the NSP & BOP (without the hydro works) for Unit 3 is about 52 % and for Unit 4 is about 35 %. It is estimated that the hydroworks, water supply and sewage for Unit 3 are finalized 49 % for the construction part and 30 % for Unit 4.

Cernavoda NPP Units 3 and 4 will produce electric power based on nuclear power, by successive transformation of the fission energy into thermal energy in the nuclear reactor, of the thermal energy into mechanical energy in the steam turbine and of the mechanical energy in electric energy in the electric generator. Each unit of the nuclear power plant is equipped with a nuclear reactor of CANDU-PHWR-6 type (Canadian Deuterium Uranium Pressurized Heavy Water Reactor). This type of reactor is using heavy water both as moderator and coolant, in two separate systems. The fuel is natural uranium.

Passing through the condenser, the steam is cooled with water taken from the Danube River via an open intake duct connected to Race 1 of the Danube - Black Sea Canal (DBSC). The cooling is done in open circuit, the cooling water is taken from the derivation canal and then it is discharged either to the Danube or to the Danube - Black Sea Canal race 2. For cooling water supply, there are considered the works for improvement of water intake from the Danube River into the Cernavoda Hydro Scheme, performing hydro-constructions in Bala area and Race 1 of Danube - Black Sea Canal.

In the Cernavoda NPP site, the buildings for the 5 reactors have been constructed and some of the components and services common to Units 3 and 4 and to the other units have already been constructed or provided.

The works required for the Units 3 and 4 finalization will consist of the following categories:

- civil works

- equipment and pipe installation works,
- electrical, instrumentation and control equipment works,
- clearing & flushing of the process systems and their hydraulic testing,
- commissioning tests.

The construction period is estimated to be 64 months and the commissioning scheduled for middle of 2013 for Unit 3 and first half of 2014 for Unit 4.

The design life for each nuclear unit is 30 years.

The time period for a nuclear power plant decommissioning depends on the radioactive inventory, the selected option for decommissioning and the decommissioning techniques used, and it can vary from several years to decades. The decommissioning plan is usually produced in three stages: initial, ongoing and final. The decommissioning plan will be periodically reviewed in compliance with National Commission for Control of Nuclear Activities regulations, taking the opportunity to adopt the decommissioning techniques and technologies made available due to the worldwide experience in the field up to that moment.

Waste management

In compliance with the Governmental Ordinance No. 11/2003 modified, supplemented and approved by Law no. 320/2003, the nuclear spent fuel and radioactive waste management including the final disposal, is developing upon the satisfaction of the national nuclear safety standards, the standards on ionising radiation protection of occupationally exposed personnel, population, environment and property as well as upon the agreements Romania is part of.

National policy for radioactive wastes management corresponds to the international requirements, as established by ”Common convention upon safety management of spent fuel and upon safety management of radioactive wastes”, elaborated by IAEA and ratified by Law No. 105/1999, as well as to the radioactive wastes management policy being promoted at EU level.

The main objective of the national policy for radioactive wastes management is that of providing a theoretically null negative impact and respectively a minimum reasonably possible one, of the wastes management activities upon population and environment. The first step in this direction is provision of the conformity of management process with the principles recommended by IAEA by the document "Safety Series No.111-F, Fundamental principles of radioactive wastes management".

The co-ordination, at national level, of the safe management process of the nuclear spent fuel and radioactive wastes generated by the nuclear licensees as well as their final disposal are part of the National Medium and Long-Term Strategy.

The National Strategy states the general procedure for organizing and developing the stages of nuclear spent fuel and radioactive waste management.

The National Strategy is applicable to all the stages of radioactive waste management process including their final disposal, and to all the nuclear facilities.

In Romania, the jurisdictional authority at national co-ordination level of the safe nuclear spent fuel and radioactive waste management, including the final disposal is the National Agency for Radioactive Waste - ANDRAD. ANDRAD is responsible for final disposal of nuclear spent fuel and radioactive waste in Romania.

The nuclear and radiological unit licensees that generate or possess radioactive waste must elaborate medium and long-term strategies regarding their own activity, strategies that must harmonise with the National Strategy on radioactive waste management.

The waste management at Cernavoda NPP includes the initial steps of waste pre-conditioning as defined in the Fundamental standards on safe nuclear radioactive waste management and IAEA Safety Series No. 111F "The Principles of Radioactive Waste Management".

Cernavoda NPP Design provides installations capable to ensure the safety management of radioactive waste, and the radiological protection of operators, population and the environment.

Except the radioactive wastes in the process of electricity generation, non-radioactive (chemical/non-chemical) liquid/solid wastes will also be produced in Cernavoda NPP Units 3 and 4.

The non-radioactive wastes generated by the Cernavoda NPP Units 3 and 4 operation will be approximately the same as the wastes generated by the Cernavoda NPP Unit 1. All the technical means for their management will be provided, as per the legislation in force.

Analysis of alternatives

The opportunity for constructing Unit 3 at Cernavoda started from the possible evolution of the electric power demand in Romania until the year 2025. The possible evolution of such a demand is based on the following official documents: the strategy for the increase of power efficiency in Romania, the „Road Map in the power field of Romania's adherence to the European Union".

Starting from the probable evolution of the power demand in the period until the year 2025, the followings were accomplished:

- a basic scenario on basis of the predicted GDP evolution as per the Road Map;
- a pessimistic hypothesis-based scenario considering the power consumption "freezing" at the value of the year 2005;
- a minimal hypothesis-based scenario according to which a more moderate GDP annual increase and a lower average annual reduction of energy intensity were accepted.

The criteria proposed for the comparison of the development scenarios on long and average term for electric and heating power production fields are grouped up in three categories:

- technical-economic criteria;
- environmental impact criteria;
- social impact criteria.

When developing the analysis considering the technical-economic criterion, the total updated costs (CTA) on the analysed period for the 2005–2025 scenarios were compared. Also within CTA criterion, some criteria considered as safety criteria in the fuel supply and the weight of the stationary means that may be re-used in case that the initial investment plan is modified, have been analysed.

Within the environmental impact criterion, the analysis included the following aspects: impact on the surface waters, impact on the soil, underground and ground waters, impact on health, impact upon the harvests and material, impact caused by greenhouse gases emission.

The multi-criteria analysis that offers an overall image on the considered scenarios has finally indicated “C Scenario” which includes Cernavoda NPP Unit 3, as favourite. The conclusion is the same when Unit 4 is included in the multi-criteria analysis. This conclusion becomes more evident when considering the expected natural gas tariff and pressure upon its increase in future, become higher.

9.3. Methodology

The potential impact of the Cernavoda NPP Units 3 and 4 was assessed on the basis of the legislation, starting from the documentation of SITON that presents this project. The existing regulations specify the procedure and the main aspects for environmental impact assessment.

The EIA report for Units 3 and 4 used also information and results from environmental impact assessment studies carried out by ICIM for Unit 1, Unit 2 and other activities in this site. Specialized studies elaborated by ICIM or other research or design institutes and organizations were used in relation to various aspects necessary to be analyzed within the EIA for Units 3 and 4. These studies refer to the Cernavoda NPP activities, focusing on environment components and their protection. The specialized studies were carried out according to specific methodologies in each field.

The Units 3 and 4 design includes many solutions and measures for preventing or diminishing the potential impact on environment components. They address generally the environment, and also each environment component.

According to the existing legislation, the EIA report analyzes the potential impact of the completion and operation of the Cernavoda NPP Units 3 and 4. Direct and indirect impact aspects are taken into consideration, as well as the cumulated impact, having in view the Units 3 and 4 operation simultaneously with Units 1 and 2.

A special attention was given to the radiological impact.

The non-radiological impact is analyzed taking into consideration each environment component.

9.4. Impact on Waters

Water bodies, water sources, receptors

The Cernavoda NPP site is at a relatively small distance from the Danube River, on the northern side of the Danube - Black Sea Canal (DBSC). From Chiciu - Silistra and Calarasi, the Danube River is divided in two branches: Dunarea Veche (east) and Borcea (west), that join downstream of Harsova. After 25 km from this ramification, the Bala branch connects the branches Dunarea Veche and Borcea. The Cernavoda town is located at about the middle of the branch Dunarea Veche, about 75 km downstream from Silistra and 62 km upstream from Giurgeni (about 50 km upstream from Harsova). Just upstream Cernavoda, there is the water intake of the DBS Canal.

The necessary water for the units of the Cernavoda NPP flows from the Dunarea Veche branch through water race 1 of the DBS Canal and then through the derivation canal to the NPP water intake basin.

Since 1996, Unit 1 discharged its effluent to the Danube (at a very small distance downstream km 296) except for some periods of about 1 month when this effluent was evacuated to the DBSC. Unit 2 is envisaged to be completed and to start working in 2007, and it will discharge its effluent together with the Unit 1 effluent.

The Cernavoda NPP Units 3 and 4 will discharge their effluents consisting of cooling water and service water to the Danube branch Dunarea Veche or to the DBSC race 2, by means of the existing or partially built hydrotechnical constructions .

The effluent coming from the Cernavoda NPP consists of Danube water with some additional small concentrations of substances due to the NPP activities, and a notable thermal load according to the design. The loads in the Units 3 and 4 effluents are envisaged to be similar to those in the effluent from Unit 1. Taking into consideration the temperature increase in comparison with the receptor, it was necessary to analyze the effluent discharge potential impact on the ecosystem in the receptor, especially the thermal impact. A main support of the assessments referring to the Units 3 and 4 effluent impact and the cumulated impact of the effluent from four units is represented by the field results regarding the Unit 1 effluent effects on the Danube and on the Danube - Black Sea Canal. With regard to Unit 1, ICIM performed field campaigns (of some days) on the Danube and DBSC and studies between 1999 - 2006. The effects were assessed using physical, chemical and biological data referring to the Danube and the DBSC in the effluent discharge area, before and after the Unit 1 commissioning. The analysis and characterization of the aquatic environment state on these water courses involved the examination of many aspects and multidisciplinary activities. This was the subject of several environmental studies. The impact of the Cernavoda NPP effluent thermal load is assessed having in view the direct and indirect potential influence of the temperature increase in the effluent on water temperature and quality indicators in the receptor.

The existing conditions along these water courses are influenced by many natural factors and human activities. That is why field observation of the thermal plume and its extension, and water sampling from the river reach upstream and downstream the Unit 1 effluent discharge section were essential for obtaining data and assessments of the real situation. Successive studies were necessary on the river stretch where the heated effluent is discharged, due to the variable parameters of the water course. Each time, the dates of the field campaigns were chosen aiming at more complete knowledge of the effluent influence under various conditions. The indicators analyzed within the thermal impact study were selected on the basis of the legislation and water management license for CNE-PROD, taking also into consideration potential effects of an effluent with thermal load on the aquatic environment. The range of measurements and analyzed indicators included water temperature distribution, water reaction, oxygen regime indicators, nutrients, mineralization, specific chemical indicators, biological indicators and planktonic populations composition, microbiological parameters. The results are compared with the limits specified by the last regulations adopted starting from the Water Framework Directive 2000/60/EC.

Danube hydrological parameters, water quality

The water level and flow values on Dunarea Veche are determined by the hydrological regime upstream on the Danube and the natural splitting of the total flow into the flows along the main branches Dunarea Veche and Borcea. The data referring to Dunarea Veche branch were obtained, according to standard methodologies, by hydrological processing of the parameters measured at the Cernavoda Hydrometric Station in the interval 1961 - 2002. There were also used data regarding the year 2003, a year with special hydrological conditions (with low and very low flow values and water levels on the Danube).

The Danube River crosses several states and its water quality is subject to the monitoring activities carried out by the water management authorities from Romania and the other countries in the Danube hydrographic basin. In 1985, the Bucharest Declaration has been adopted, for the promotion of a complex program for the Danube water quality monitoring by the riparian countries. At present, the Transnational Monitoring Network (TNMN) is under operation, continuing to control the water quality indicators along the Danube. Within this framework, a series of control sections have been established for monthly water sampling for physical, chemical and biological analyses. Among these sections, the closest to Cernavoda is Chiciu – Silistra, located upstream.

On the basis of the data sets from the period 1994 - 1999 and from the year 2002, it is assessed that the average values of the Danube water quality indicators in the Chiciu - Silistra section were generally within the limits of the quality classes I and II (according to Order 161/2006).

Analyzing the data sets in the Giurgeni section (downstream Cernavoda) between 1994 - 1999, it is assessed that the average values of the indicators in the Giurgeni section were generally within the limits of the quality classes I and II.

The values of the indicators on Dunarea Veche downstream Cernavoda in 2001, 2003, 2004, 2006 close to those in the upstream section (Danube section at the DBSC intake, upstream the effluent).

The water quality indicators values are within class II in most cases. Some temporary exceeding values are determined by the existing conditions and pollution sources in the Danube hydrographic basin.

The microbiological indicators values in the Danube water, recorded between 1996 - 2000 in sections at relatively long distances from Cernavoda, show some exceeding values. The results in 2001, 2003, 2004 show fluctuant values due to variable conditions in the Danube water and variable loads from the upstream hydrographic basin.

Taking into account the results of the measurements in 2001, 2003, 2004, 2006, the water temperatures on the Danube stretch downstream Cernavoda can be characterized as being close to the natural regime (shown by the hydrological data measured at the Cernavoda HS), with some local differences in a narrow area in the neighborhood of the right bank downstream the Cernavoda NPP effluent discharge.

The aquatic biocenosis depends on physical and chemical parameters in the aquatic environment (for example the organic load, oxygen regime, mineralization, nutrients concentrations, toxic substances presence), on the substrate nature, slope, stream velocity, thermal regime, etc.

The biological analysis carried out by ICIM in 2001, 2003, 2004, 2006 comprised the study of the qualitative composition (taxonomic groups, species, prevailing forms) and of the quantitative composition (density, density abundance, biomass, biomass abundance) of the phytoplanktonic and zooplanktonic organisms population.

The results of the biological analyses in all the years show that the Danube water quality is within the ß-mesosaprobe category (moderate load with biodegradable organic substances).

The Danube ichtyofauna in the Oltina-Harsova sector includes 66 species, of which 28 are more frequently met.

DBSC water quality

The DBSC hydrotechnical system comprises races of the main waterway named the Danube - Black Sea Canal (that connects the Danube and the Black See), and races of a long branch named the Poarta Alba - Midia Navodari Canal (PAMNC). The DBSC consists of three water races, separated by the Cernavoda and Agigea locks.

The DBSC water quality was analyzed on the basis of data from several years between 1996 and 2006. Beginning from the campaign of ICIM in May 1999, when the Unit 1 effluent was discharged into DBSC race 2 over one month, water temperature was measured in the sampling sections and in many other points along the canals.

The DBSC and PAMNC receive water from the Danube with its chemical load. Water quality in the DBSC race 2 is the result of several factors: the loads coming with the Danube water, the loads from local sources, specific water flow conditions and ship traffic influence, climate, aquatic biocenosis evolution during each year, processes in the aquatic environment.

The dissolved oxygen values were high, within quality classes I and II, the DBSC and PAMNC water being well oxygenated. Most values of the other analyzed indicators were within quality class II. Some temporary exceeding values were found sometimes for nutrients. The water quality state was comparable from a year to another, both in spring and autumn.

The microbiological indicators were analyzed in 1999, 2001, 2004 in the same sections where chemical indicators were determined. The values of the indicators reflect the influence of the water sources (the Danube river), of various contamination sources along the canal and the influence of other local factors.

Examining the measured temperatures, it was found that water temperature in DBSC without heated water discharge into race 2 had small natural variations from a point to another, within about 1 °C, under the influence of various factors.

During the periods when the Unit 1 effluent with its thermal load was discharged in DBSC, the measured data showed a decreasing temperature distribution from upstream to downstream, along DBSC race 2 and along PAMNC. The temperature values include the effects of the Unit 1 effluent mixing with different flows coming in some days from DBSC race 1 through SPC, and also the effects of the variable meteorological during the effluent flow from Cernavoda to Agigea.

The aquatic environment in the DBSC is a young ecosystem with a structure permanently influenced by the Danube River and by the pollution sources generated by the human activities in the Danube hydrographic basin. The biocenosis trophical structure in the DBSC aquatic environment is basically like that in the Danube, which is the main source of water supply for DBSC. Fish fauna shows characteristics similar to the Danube fauna.

Biological research campaigns were carried out by ICIM on DBSC during 1999, 2001, 2004 and 2005 aiming at observing the biocenosis characteristics before and after a period of one month of effluent discharge from Unit 1 into water race 2 of DBSC. Biological analyses were also performed in the year 2006.

The primary productivity varies in the DBSC and PAMNC water from season to season, depending on several factors, including the nutrients concentrations.

In all the control sections, the correlation between the biotic component and abiotic component analyses results was taken into consideration for water quality assessment from the biological point of view. Based on the values of the quantitative biological indicators (phytoplanktonic density and biomass), on the bioindicator species presence and the values of the main physical and chemical indicators, it was assessed that the DBSC water was within the beta-mesosaprobe category, the good quality class, in the analyzed periods in all the years. In this category, high dissolved oxygen quantities are present in the water, the organic load is reduced, the self-purification process is advanced, the organic matter mineralization is almost finished.

A general characteristic of the organisms populating the β-mesosaprobe category, is the high degree of sensibility to the dissolved oxygen concentration decrease and to the pH variations.

Impact of water intake and restitution

Taking the necessary flow from the Danube, through the water race 1 and the derivation canal, for supplying the Units 1, 2, 3 and 4, has not significant effects in the Danube downstream reach, usually. During minimum flows periods, the water restitution in Danube makes the effects reduced, occurring only on a few km length sector, between the DBSC intake and the Cernavoda NPP effluent discharge section.

The cooling water discharge in the water race 2 of DBSC during periods with very low flow on the Danube can assure the necessary water volumes for the users from this water race. This contribution is important, especially if the flows used by various consumers are close to those envisaged in the DBSC design, reaching total values that could be difficult or impossible to be taken from the Danube during minimum flows.

The DBSC water race 1, the derivation canal and the distribution basin were sized for higher flows than those necessary for the Units 1, 2, 3 and 4 simultaneous operation, starting from the needs of all the users. Therefore, the flowing speed increase on this route by the Units 3 and 4 operation together with Units 1 and 2 will not result in canal sides additional erosion and will not result in difficulties for navigation.

The Cernavoda NPP discharges a fraction of its effluent into the upstream part of the water intake basin during some periods in the cold months of the year. This heated water flow has the purpose to prevent frazil ice entrance to the pumps and to ensure an adequate temperature of water according to the technical requirement for the power plant circuits. The recirculated flow (heated water) is taken by the Cernavoda NPP pumps, through the distribution basin, after it mixes with the flow coming through the derivation canal (water with lower temperature). The partial recirculation of the cooling water to the NPP intake canal is not expected to have any negative impact on water temperature in the derivation canal or in the DBSC race 1.

Impact on water temperature on the branch Dunarea Veche

As regards the separate thermal impact of the Units 3 and 4 effluent, it is remarked that the heated water flow from the Units 3 and 4 is small compared to the average multi-annual monthly flows on the Dunarea Veche branch. In the discharge downstream neighbor area vertical mixing occurs, and then the thermal plume develops gradually, with decreasing temperature difference.

The water temperature distribution along the branch Dunarea Veche, downstream the effluent discharge was estimated by calculation for characteristic hydrological and meteorological conditions.

For estimating the effluent thermal effect in characteristic situations, monthly values were used for water levels, flows, water temperature and meteorological parameters, as well as the values of the Units 3 and 4 effluent parameters.

Under the effect of the effluents from two NPP Units, a water temperature increase of 3 °C is anticipated to occur within the initial vertical mixing area and beyond it in some situations, along the river right part. A water temperature increase of 2 °C occurs at the right bank on a longer distance than in the case of Unit 1, but the influenced area is still small. This is a small variation of the water temperature in comparison with the natural temperature variations on the lower Danube from a year to another, every month. In most part of each cross-section on Dunarea Veche downstream the effluent, the natural thermal regime of the Danube water is not modified.

The fact that the thermal impact on Dunarea Veche of the Units 3 and 4 effluent occurs in limited area is also shown by the results of the measurement and estimations about the Unit 1 effluent. The measured Unit 1 effluent temperatures are within the limits established by the regulation NTPA 001 (Government Decision 352/2005) for waste waters discharge into surface waters and by the Water Management Authorization issued by the waters authority for the Cernavoda NPP. The data measured both in periods with usual hydrological and meteorological conditions and also during time intervals with extreme conditions provide results regarding the effluent thermal influence in the area downstream the discharge, in various situations encountered in the years 2001, 2003, 2004, 2006. The data sets obtained in all seasons show that along the initial vertical mixing area, water temperature increase due to the effluent from a unit becomes lower than 3 °C in most situations, and the corresponding transversal area is much less than a quarter of the branch cross section area. Further downstream, the water temperature differences due to the Unit 1 effluent decrease under 2 °C at a distance of about 2 km in most situations. During partial recirculation of the effluent, although the flow discharged from one unit into Dunarea Veche is smaller, the results show that the effect downstream is not very different.

The physical and chemical parameters of the discharged water from Units 1, 2, 3 and 4 are similar to the case of one unit, the differences coming from the increased effluent flow. The total design water flow discharged from Units 1, 2, 3 and 4 is 216 m^3/s, in comparison to 108 m^3/s from two NPP units. The effluent temperature increase above the source water is envisaged to be similar as for Unit 1.

Due to the effluent flow value (four times the flow value from one NPP unit), the cumulated thermal effect of the effluent of Units 1, 2, 3 and 4 on the branch Dunarea Veche is spatially larger, but the temperature in the discharge section is about the same as in case of one unit. Along the branch, the effluent influence occurs at longer distances, because of the effluent flow value. The branch transversal section part influenced by the effluent with 3 °C increase can be generally up to a quarter, in conditions of multi-annual average monthly flows on the Danube (flow values larger than 1500 m^3/s).

Impact on water temperature in the DBSC race 2

As regards the separate thermal impact of the Units 3 and 4 effluent during its discharge to the DBSC race 2, it is remarked that the water temperature in the upstream section of water race 2 is the NPP effluent temperature, or it is lower if the effluent mixed with an additional flow taken directly from water race 1 by SPC. The temperature values in the upstream section of the water race 2 are less than the limit of 35 °C specified by NTPA 001, under usual values of Danube water temperature.

The separate thermal impact of the Units 3 and 4 effluent in the DBSC race 2 in characteristic situations was estimated by calculation, in two cases of mixing and thermal transfer conditions. The results indicate expected limits of the Units 3 and 4 effluent thermal effect in DBSC water race 2.

The temperature measurements carried out for the case of Unit 1 and the estimations related to Unit 1 provide an image regarding the separate thermal impact of the effluent from one unit (Unit 3, respectively Unit 4), on the DBSC race 2. The measured data reflect the existing conditions in the respective periods (water flows used from the canal, water flows discharged from Unit 1 into race 2, flows from SPC for water supply of race 2, lock operations, various meteorological conditions).

Having a temperature similar to the case of one NPP unit, the effluent from 4 units leads to a similar water temperature in the upstream section of the DBSC race 2 during the months without water need for irrigation.

During summer months, the effluent from Units 1, 2, 3, 4 can cover the water requirements for irrigation, without supplementary flow from race 1 (from race 1) that could be necessary in addition to the effluent from one or two units of the NPP. The thermal impact along race 2 of the effluent from 4 units is given by the higher upstream temperatures in some months and the smaller flow time along the DBSC race 2.

Impact on water quality on the branch Dunarea Veche

During the Units 3 and 4 completion period, the impact on waters will be lower than that produced during the realization of the NPP platform and Unit 1. The impact will be reduced to minimum through equipment and vehicles periodic maintenance, and by proper handling and storage of fuels and materials, and waste management.

The domestic waste waters will be collected by the existing sewage network, similar to those that result from other buildings within the NPP site. They will be treated in the future waste water treatment plant of the Cernavoda Town.

For the Units 3 and 4 operation period, the data obtained during the campaigns in 2001, 2003, 2004 and 2006 are useful for assessing the impact of the effluent from one NPP unit and provide information for the case of two or more units.

Besides the above mentioned quality indicators, analyses of specific substances used at Unit 1 during normal operation were also performed.

The Units 3 and 4 effluent has the chemical loads from the Danube water and an increased temperature in comparison with the water source. It includes also some waste waters from the NPP. The waste waters discharged from the water treatment station are those that come from decantation (sludge), from ionic filters regeneration and washing water from the mechanical filters. The water treatment station is equipped with a system for neutralizing the waste waters resulted from the regeneration process, equipment washing, floor, etc. In the cooling water the concentrations of the chemical substances (calcium, magnesium, natrium, chloride, sulfates) and of the suspended matter from STA reduced very much. The water from neutralizing tanks of STA is discharged only after the pH value control, carried out on the neutralizing pump discharge line, as well as in the laboratory. The discharging valves are opened only if the pH value is inside the permitted limits for discharging. It results from the above that the discharges from the water treatment station in the heated effluent and further in the receptor have no significant impact.

The measured values upstream and downstream the effluent discharge section have normal variations from a time interval to another and from a point to another, as it is usual in the Danube water.

The dissolved oxygen concentrations are in most cases within the quality classes I and II, indicating that the Danube water is well oxygenated.

The values of the indicators are around those in the upstream section, within class II in most cases. Some temporary exceeding values are determined by the existing conditions and pollution sources in the Danube hydrographic basin.

CNE-PROD takes regularly water samples from the effluent, in a section (the Seimeni bridge) before the discharge into Dunarea Veche. The water source quality is also monitored taking water samples from a section (the NPP bridge) at the entrance to the NPP water intake basin. The results are reported to the waters authority.

The measured values are below the limits specified in the Water Management Authorization and in NTPA 001.

An important quality indicator for the aquatic organisms and for water self-purification is the dissolved oxygen. Its concentration is influenced by various phenomena and processes at the interface with the air and inside the aquatic environment. One of the factors is water temperature. The water temperature increase due to the effluent occurs only in a rather small area compared to the river channel width. The temperature differences, both measured and calculated, are within a range of a few degrees and they have not any significant effect on the oxygen concentration. The fact that the oxygen regime is not significantly influenced by the effluent is confirmed by the sets of measured values during the field campaigns.

The variation of the values of some chemical indicators (dissolved oxygen, nitrogen, phosphorus, organic matter) depends also on the phytoplankton biomass variation (influenced by water temperature). The results of the biological analyses of the water samples taken during the field campaigns showed that the total phytoplankton biomass was within the Danube river characteristic limits, as well as in the case of the chemical indicators. Therefore, the chemical indicators were not modified because of the water temperature.

The analyses of the chemical indicators did not find any significant changes of their values on the branch Dunarea Veche due to the Unit 1 effluent. Therefore, it is assessed that the impact of the Units 3 and 4 effluent on Danube water quality indicators will be insignificant.

If the effluent comes from four units, its temperature difference over the Danube water temperature and its chemical concentrations are expected to be similar to the case of one NPP unit. The substances concentrations in the effluent are at the same level as in the Danube water. Only the flow value will be larger, four times. Therefore, the thermal impact will occur at a longer distance, but it will be local along the right bank of the river. Based on the results of the thermal effect estimation and of the studies on the Danube, it is assessed that the cumulated impact on water quality indicators, of the effluent from Units 1, 2, 3 and 4 will not be significant.

Impact on water quality in the DBSC race 2

The effects on DBSC water quality of the effluent discharged from one Cernavoda NPP unit was studied during several campaigns on DBSC and PAMNC. The results are relevant for assessing the separate impact of the Unit 3 or Unit 4 effluent discharge into DBSC race 2.

Water quality in these canals is under the effects of the Danube water chemical loads and the received waste waters. The specific water motion situation causes a high residence time that is important for physical and chemical processes in the aquatic environment and their relationship with biocenosis components.

In addition to physical indicators, the relevant chemical parameters for assessing potential effects of the NPP effluent discharge on the DBSC water race 2 aquatic environment are the oxygen regime indicators, the nutrients and the dissolved ions.

The values of the dissolved oxygen concentration are within the quality classes I and II. The water in the DBSC and PAMNC is well oxygenated mainly due to the natural conditions. The biochemical oxygen demand (BOD_5) values were within quality class II in most cases, with some exceeding values.

The nutrients (nitrates, ammonium, phosphorus) were found with values within quality class II with some exceeding concentrations indicating higher loads from the Danube and from the waste water sources existing along water race 2. These loads represent a nutritive support for phytoplankton growth (observed during summer in 1999 and 2001).

The water quality indicators values obtained by ICIM and CNE-PROD for the effluent were within the limits specified by NTPA 001 and the Water Management Authorization issued for CNE-PROD.

The effluent thermal and chemical loads effects were assessed by examining the DBSC water indicators values under its influence, in comparison with existing values in the absence of the effluent. It results that the dissolved oxygen values depend mainly on the natural conditions in various periods. The other indicators values are determined especially by the concentrations in the Danube water and by sources (other than the NPP effluent) existing along the DBS Canal. The results of the campaigns indicate that the water temperature increase in the DBSC water race 2 due to the effluent from one NPP unit had not any apparent direct effect on the values of the chemical indicators. The dissolved oxygen (important for biochemical processes, water quality and aquatic organisms) had usual values, within the quality classes II and I.

The data sets taken into consideration (with the effluent flowing along race 2) were obtained during spring and autumn. Under the highest Danube water temperatures during summer, the effluent thermal effect can favor phytoplankton growth with potential influence on some chemical indicators. Actually, the influence of the increased water motion along water race 2 has also to be considered. The phytoplankton growth that occurred naturally in some periods without the effluent effect was temporary and the aquatic ecosystem state returned back to the usual situation after the water temperature decreased. Aquatic vegetation was also observed in some stretches of race 2.

The effluent discharge from two or more NPP units in water race 2 changes the water motion regime from a quasi-stagnant water body to a slowly flowing water stream. This change helps the water replacement in the DBS Canal reducing much the water residence time. The increased water circulation is expected to be favorable for water quality.

On the basis of the direct impact data mentioned above and the estimated thermal effects, it can be assessed that the separate impact of the Units 3 and 4 effluent will occur mainly on water temperature distribution. The effluent is not expected to change the water quality class as regards the dissolved oxygen or to have a notable direct effect on other quality indicators. Only some temporary indirect effects are possible sometimes, during the warm season, due to algal growth.

The cumulated effect of the effluents from Units 1, 2, 3, 4 is higher on water temperature. The dissolved oxygen values are expected to remain in the quality class II. The chemical concentrations will be similar, so that direct effects on water quality chemical indicators are not expected. During the warm season, the thermal effect can lead to higher temperatures favoring algal growth and biochemical reactions in the aquatic environment, that can influence some water quality indicators. Therefore, the cumulated effluent influence on the water quality in the DBS Canal is more intense during some periods. However, the effluent causes faster water motion and replacement in water race 2, with shorter residence times that are in favor of water quality.

Impact of specific substances

The Unit 3 effluent contains some specific chemical substances that are used currently during normal operation. Among these, hydrazine (reducing agent) reacts with the oxygen, resulting nitrogen, and under certain conditions the hydrazine is decomposed, resulting ammonia and nitrogen.

The chemical analyses of water samples from Cernavoda NPP effluent, from the Danube and DBSC, carried out by ICIM and by CNE PROD (regularly) within its own monitoring program, did not show detectable values for hydrazine, morpholine and cyclohexilamine in the Unit 1 effluent or in the receptor water.

Having in view that the hydrazine existing in the water can lead by chemical transformations to increase in the ammonium content, the concentration of ammonium and its equilibrium with ammonia were also examined during the studies on the Danube and the DBSC. The results indicated that the ammonium values were within usual limits in the Danube and DBSC, without showing any increase because of eventual hydrazine decomposition.

Taking into account concentrations of these substances in the Units 3 and 4 effluent similar to those in the effluent from the Unit 1, and the results mentioned above, it is estimated that the influence of these substances will be similar, without effect on water quality indicators.

From the Units 1, 2, 3, 4, the total used quantities of these substances are bigger, but the concentrations in the effluent are similar because the total flow value is four times larger. Therefore, the concentrations resulting in the receptor will continue to be below the detection limits as in the case of one unit. Keeping these substances concentrations below the allowed limits and monitoring them will ensure conformity with the regulations for surface waters quality protection.

The limits for specific substances in the effluent are established on the basis of specialized studies according to the legislation.

Impact on components of the aquatic biocenosis on Dunarea Veche

The impact of the Cernavoda NPP effluent from Units 1, 2, 3 and 4 on the biocenosis in Dunarea Veche is estimated starting from the studies regarding the influence of the Unit 1 effluent.

During several studies, the aquatic environment quality was analyzed on the basis of both biological results and the physical and chemical indicators.

The phytoplankton and zooplankton organisms in the Danube upstream and downstream the effluent discharge section were found with naturally varying values according to the seasonal conditions. Both within and without the thermal plume, the values found by means of the water samples are comparable. Downstream the effluent it was found a similar range of values as upstream in the Danube. Therefore, the results obtained for the phytoplankton and zooplankton during the campaigns carried out by ICIM do not show an influence due to the effluent.

Many planktonic organisms found in the water samples are bioindicators of water load with biodegradable organic matter.

Therefore, it is appreciated that the Danube water is within the beta-mezosaprobic category. It can be assessed that the effluent from two NPP units does not influence negatively water quality and the biocenosis on Dunarea Veche.

At this moment, the ecological state of the studied Danube sector was not affected by the Unit 1 effluent thermal and chemical loads. This is also due to the Danube physical characteristics in the studied area, the flowing velocity and the large flow values, which assure rapid water homogenization.

Taking into account the estimated impact of the Cernavoda NPP effluent (after the Units 3 and 4 commissioning) on water temperature and water quality physical and chemical indicators, as well as the low level of specific substances in the effluent and the much higher Danube flow, it is expected that the effluent influence on biocenosis components will not be significantly different.

Future monitoring activities on the Danube and also the regular analyses carried out by the Cernavoda NPP after Unit 2 commissioning and after Units 3 and 4 commissioning, will provide further field data to confirm in time the effluent quality within the admitted limits and the absence of some negative effects from the Units 1, 2, 3 and 4 effluent on the biocenosis in the Danube.

Impact on components of the aquatic biocenosis in DBSC

The primary productivity varies in the DBS Canal and PAMN Canal water from season to season, depending on several factors (including the nutrients concentration). The phytoplankton biomass and the evolution of other aquatic organisms vary annually depending on the particular conditions during each year and growing sometimes more when the conditions are favorable. The measured biomass values reflect the existing different growth in different years.

In all the control sections, the correlation between the biotic component and abiotic component analyses results was taken into consideration for water quality assessment from the biological point of view. Most of the bioindicators species found in the water of the DBSC and PAMNC belonged to the beta-mezosaprobe category, and a few species belonged to the alfa-mezosaprobe category. Depending on the values of the quantitative biological indicators (phytoplanktonic density and biomass), on the bioindicator species presence and on the structure of the entire biocenosis, the DBSC and PAMNC water was biologically within the β-mesosaprobe category. Specific to this category, high dissolved oxygen quantities are present in the water, the organic load is reduced, the self-purification process is advanced, the organic matter mineralization is almost finished. A general characteristic of the organisms in the β-mesosaprobe category aquatic environment, is the high degree of sensibility to the dissolved oxygen concentration decrease and to the pH variations.

Under conditions of high water temperature at the DBSC intake, and low supplementary flow into the canal, taking into account the available natural amount of nutrients in the water race 2, water temperature increase could lead to algal development. Large algae development, if it occurs, can lead, in time, to consequences on some biotope chemical components (for example, high oxygen consumption) and some quality indicators that are important for water use (especially source for drinking water treatment). When water temperature returns to normal values (in autumn), the biocoenosis recovers in time.

In order to prevent some undesirable effects, the water temperature and other parameters monitoring will be necessary in some periods, during and after the Units 1 and 2 effluent discharge into DBSC water race 2. Later, after Units 3 and 4 commissioning, the effects of the effluent from Units 1, 2, 3 and 4 on the DBSC aquatic environment will have to be monitored. The DBSC water state monitoring will be performed within the surface waters state analysis by the water management authorities, according to the existing regulations.

Impact on water use

The surface waters in the Cernavoda NPP area are used for navigation, industrial water supply, as water source for drinking water treatment, for irrigation, and commercial and recreation fishing.

Danube is used as a raw water source for drinking water supply for Cernavoda town, the intake being located in a section upstream the Danube - Black Sea Canal (DBSC) water intake.

Along the Danube sector between the NPP effluent discharge section and Harsova, there are water intakes of three irrigation systems. Only the Seimeni irrigation system is supplied from an area relatively influenced by the heated water plume. The effluent influence on water temperature in that area is rather small and it is unlikely to occur negative influences of the thermal factor on the irrigated plants.

Fog occurrence frequency in the Cernavoda area was analyzed on the basis of data sets obtained by the meteorological stations. This phenomenon was examined in specialized studies, in relation to the main relevant factors, including the underlying surface temperature. The heated effluent has an increased surface temperature in comparison to the natural water temperature.

For the area in the neighborhood of the effluent discharge into the Dunarea Veche branch, it was estimated an increase in the fog phenomenon annual frequency by 10 % in the heated water discharge area, due to one or more NPP units. Water temperature increase occurs in a relatively small area on the right part of the river so that the effluent influence on fog frequency is not important. After Unit 2 and Units 3 and 4 commissioning, the fog occurrence conditions in the effluent discharge area and its frequency will be practically the same, but on a longer sector towards downstream. The possibly influenced area on Dunarea Veche is relatively small, on the right side, and the effluent effect is not important.

In the DBSC hydrotechnical system, the intake of the water treatment station on PAMNC is far from Cernavoda, on a canal with slow flow, and the water temperature increase, lower than in the upstream race 2 section, will be diminished by mixing with cold water from underground.

As regards the impact on the water intake for the existing irrigation systems along race 2, the water transport long distances significantly reduce the thermal factor impact on the systems.

As in the case of the discharge to the Danube, it was estimated that the effluent could lead to an increase of fog phenomena annual frequency with about 10 % (with some seasonal variations) at the upstream end of the DBSC race 2. During the discharge of the Units 1, 2, 3 and 4 effluent into DBSC, water temperature increase could favour fog occurrence on a longer downstream sector. The effluent effect on fog occurrence diminishes with the distance increase from the heated water discharge section, in any season.

Measures for preventing and mitigating the impact on waters

The operation procedures aim to minimize the impact on waters of the Units 3 and 4 activities.

The main installations for decreasing the pollutant load of waste waters are the following: oil separator for the waste service waters from the motor oil station and the rainfall waters from the tank trays, desilter for rainfall waters, neutralization system for the waste water resulted from the regeneration process, equipment washing, floor washing, etc., decontamination subsystem provided for decontamination of the liquid wastes.

The accidental pollution prevention measures will be taken according to the requirements of the legislation.

Moreover, the operation and maintenance procedures will be strictly applied at Units 3 and 4, with the purpose to prevent any causes of accidental pollution of waters. The installations and equipments will be verified periodically, the substances and wastes management will be rigorous, and the personnel training will include accidental pollution prevention topics.

The absence of accidental pollution of waters during the activities at Unit 1 shows the effectiveness of the measures and procedures applied within the Cernavoda NPP site.

The monitoring activities provide data so that to keep permanently the effluent within the admitted parameters for limiting its impact.

9.5. Impact on Air

The gases and dust emissions from equipment and vehicles used for construction will have local, temporary and low effects.

The impact due to the sanding equipment, used for pipes cleaning, will be minimized if the dust will be collected by air filtering systems.

The noise and vibrations generated by vehicles and construction equipments act within limited areas, especially within the site, during short periods, so it can be assessed that the impact to human settlements will be insignificant. The Cernavoda town is protected by the hill that separates it from the site.

The equipment inspection and regular maintenance, maintaining and watering the roads will reduce emissions to air and dust.

The impact due to emission from the welding operations will be significantly reduced by personnel protection equipment and by exhausting.

The effects of the used substances will be prevented or diminished by proper storage, respecting the norms for their handling and use, ventilation systems, in order to reduce as possible the impact.

The Units 3 and 4 commissioning and operation involves its own installations and other utilities, services and installations that are common to the Units envisaged to be realized on the NPP Site.

The main pollutants that are found in the released gases are collected, properly treated and controlled by various systems. There are no possibly contaminated air releases from the plant systems without being controlled and filtered and then diluted. The gaseous emission are limited so that to comply with the regulations and requirements.

Other potential gaseous emission sources, which are not controlled by ventilation systems, are the steam valves that can release steam during abnormal conditions.

There are also sources of vapor and smell releases: the Diesel generators, the oil storage tanks (where the vapors and drops amounts are notable, collecting systems are designed) and the water treatment station sewage system. These pollutant releases are small and they do not cause any significant impact, as shown by the situation at Unit 1.

The Diesel generators are practically in stand-by, their operation being necessary only under electrical energy supply failure, and only for a limited duration. The Diesel generators used Euro 3 Diesel fuel with about 0.05 % sulphur content. The pollutant concentrations resulting at a total outflow of 13000 m^3/hour burnt gases are within the admissible emission limits. The Diesel generators work during short time intervals only (when they are tested), and therefore they do not influence systematically air quality or other environment components.

Environmental protection is ensured mainly through administrative and design measures, as well as through a reduced volume of gases releases from spaces without ventilation systems.

The noise and vibrations impact on human settlements due to the various equipments and installations, will be insignificant. Many of noise and vibrations generating installations (pumps, ventilators) are equipped with attenuators and damper and they are placed in buildings. The noise and vibrations level generated by other equipments (steam valves, electrical transformers) will not exceed the limits specified by regulations, or, where these limits will be exceeded adequate equipment will be provided for the personnel protection.

Between the Cernavoda town and the site, there is a natural obstacle (a hill). Due to the attenuation with the distance, by air absorption and diffraction, the Units 3 and 4 contribution to the equivalent noise level in the town is assessed as negligible.

During the Units 3 and 4 operation period, the maintenance activities will be performed rigorously, contributing to the good condition of the equipments, so that all the plant systems work properly. Consequently, the emissions to air will be properly treated and they will be within the parameters.

The internal procedures will include fast identification of any unexpected emission causes so that to take appropriate measures.

9.6. Impact on Soil, Ground Water, Subsoil

Taking into consideration that the main buildings of Units 3 and 4 are already constructed and further work outside will be done for finalizing some exterior surfaces and for finishing them, the impact on soil will be less than in other construction sites.

The impact on subsoil of the previous engineering works for preparing the site and constructing the buildings and various systems (with constructions under the land surface) is not significant and will not be modified during the Units 3 and 4 construction period.

As regards the building site organizations, they belong to the companies that carry out the works.

The leaks of oil, fuel, chemicals will be reduced to minimum by the proper maintenance of equipment and vehicles.

Respecting the leaks reducing measures and procedures and the waste management procedures, the impact on ground water will be insignificant.

The leaks resulted during handling and storage will be prevented and reduced by strict application of the procedures, as well as by adequate training of the personnel, and by specifying the environmental protection responsibilities.

Proper management of toxic substances (paints) and care during operations using them will prevent their potential impact on soil.

The waste generated during the execution period are common wastes similar to those resulted from building-installing works for industrial objectives. The wastes management will be carried out inside the building site, according to the existing legal provisions and practices in the NPP Site. In these conditions, the waste management activities will not have a significant adverse effect on soil.

The non-radiological impact of Units 3 and 4 operation on soil, groundwater and subsoil could be mainly generated by the substances and materials use and handling, by the waste management or by leaks and infiltration in soil.

In order to avoid the soil and subsoil pollution by substances or materials used or by wastes, the following are provided: installations, devices, correspondingly arranged spaces, detailed measures and procedures on material type and category, regarding their transport, handling, storage, collecting and management. Also, the impact will be reduced to minimum by the specific regulation application.

The main chemicals used are stocked in the supplier package or in cistern. The cisterns are grouped on a anti-acid plated platform that contains the chemicals accidental leaks and allows their transfer to the waste water reservoirs. The discharging platform of chemicals from the railway tanks is anti-acid plated and equipped with transfer facilities of waste water to neutralization.

The reagents used in the chemical laboratory are stocked in rooms with special destination, in safety conditions: freezer for potentially explosive substances, metallic locker with double walls for flammable substances, metallic locker for toxic substances, and their use is strictly regulated.

The use of substances of PCB type is not envisaged at Units 3 and 4.

The liquid non-radioactive waste (solvents, oils) will be collected in barrels for their storage, analyses (for identification and contamination degree determination), conditioning and transfer outside of the power plant. The disposal procedures take into account authorized contractors or are established conforming to environmental protection regulations.

The leaks that appear in normal and abnormal operation regime of some technological systems are collected by the inactive drainage system and discharged in the rainwater sewage. The system ensures also the possibility to collect the water-oil mixture from the turbine main bearing and to separate the oil from water.

The rainwater from the black oil husbandry and discharging platform, after their purification in the black oil separator, is collected by the rainwater sewage system.

The drainage system and sewage network efficiency is ensured by their proper maintenance. Care will be taken to avoid their deterioration during Units 3 and 4 completion.

Therefore, the non-radiological impact of the Units 3 and 4 activity on soil is expected to be insignificant during normal operation conditions.

In addition to the impact prevention measures taken in the Units 3 and 4 design and operation procedures, there are mitigation measures for limiting and collecting leaks, collecting wastes, and also procedures for equipments maintenance in case of leaks.

Water table shielding structure provides control of the circulation and the underground water level in the Units 3 and 4 main buildings area. This control is provided by performing a shielding drained enclosure around the buildings and drainage by pumping from this enclosure to the roof drainage system. The shielding is aimed to prevent dispersion of possible leakage resulted during U3 and U4 operation to the surface waters. Moreover, the level of surface waters inside the enclosure is maintained at levels lower than the levels of the surface waters outside the enclosure by pumping. In this way the drainage of the inside surface waters to the outside due to possible cracks in the shielding, is prevented. Water discharged is dosimetrically controlled and in case of accidental contamination, their evacuation into the emissary is stopped until the removal of the cause.

9.7. Impact on Terrestrial Flora and Fauna

The Cernavoda NPP site was prepared more than 20 years ago for five NPP units. Even at that time the necessary activities did not have an impact on flora or fauna because the former site use (before 1985) was for extraction of limestone from a quarry.

The Units 3 and 4 will be built on the NPP Site, on a constructed area, near Unit 1, Unit 2 and the other buildings and constructions necessary for the activities on the Cernavoda NPP platform. Therefore, there will not by any impact on vegetation and fauna in this area.

The construction activities to be carried out will not reduce furthermore the plant and animal species diversity, because there will not by any habitat losses or changes.

The site does not include any critical or productive habitat, and the finishing works and activities will not affect the terrestrial flora and fauna.

At the finishing moment, landscape and green spaces arranging measures will be taken.

During the Unit 1 operation (in the period 1996 - 2006), it was not observed any impact on flora or fauna in this area.

Therefore, it is assessed that the Units 3 and 4 operation will not have an impact on fauna and flora in the Cernavoda NPP site area.

At a larger scale around the Cernavoda NPP site, a potential impact on fauna or flora could be related to air or water releases.

Because the administrative and design measures lead to the limitation of non-radioactive releases in air to insignificant quantities, it results that their impact on terrestrial vegetation and fauna will not be significant.

Because the Units 1, 2, 3 and 4 effluent effect on the Danube water temperature at the water intakes of the irrigation systems is low, the use of the warmer water for irrigation, from the river stretch downstream Cernavoda, will have a practically insignificant impact or no impact farther downstream.

The impact of this warmer water on terrestrial fauna near the river (in its floodplains or the small islands) is also insignificant.

The crop irrigation with warmer water from the DBSC race 2 favors the crop development. However, the long water transport distances in the irrigation systems networks reduce the thermal factor influence, and water temperature along the irrigation canals is more influenced by the local conditions, soil temperature, solar radiation and other factors.

9.8. Impact on Landscape

The Units 3 and 4 reactors buildings are part of the set of 5 reactor buildings existing in the Cernavoda NPP site.

The completion of Units 3 and 4 will improve the landscape by finalizing and finishing exterior surfaces of the buildings and hiding some reinforcement metal bars.

The activities during the completion period will be carried out inside the Cernavoda NPP site, and much work will be done within the buildings, without negative effects on landscape.

During the Units 3 and 4 operation, the measures for preventing negative effects on landscape will comprise activities of maintenance of the buildings and installations surfaces.

9.9. Social and Economic Impact

The existence of a nuclear power plant in a zone is a factor of developing of the economic activities in the vicinity.

The operation of the Cernavoda NPP Units 3 and 4 does not perturb the economic activities in the area beyond the exclusion zone of 1 km.

The main beneficial social and economic effects of the Units 3 and 4 completion and operation will be:

- positive return of an important previously started investment;
- generation of a large quantity of electric energy;
- avoidance of greenhouse gases emission increase and of other effects that would occur by fossil fuel burning in a comparable thermal power plant;
- population employment and qualification;
- stimulation of other economic activities;
- financial sources for the population and the local administration;
- development and improvement of local infrastructure.

The impact of noise and vibrations generated by various equipments and installations on population will be insignificant. The only neighbor locality is the Cernavoda town, but there is a natural screen (a hill) between the NPP site and the town. Due to attenuation with distance, the contribution of Units 3 and 4 to the noise level in the town is assessed as being negligible.

The protection of the personnel, population and environment is a main objective of Cernavoda NPP. This objective is achieved by implementing the current practices world-wide and of the international recommendation regarding the design and operation of nuclear power plants. The following protection measures are adopted: it is established an exclusion zone of 1 km around the reactors, general arrangement is performed so that it will be no impact on the economic activities in the neighborhood, provision of restriction measures on the terrestrial transport routes located within the exclusion zone will ensure the minimizing of the reciprocal impact nuclear power plant - terrestrial transport activities, provision of restriction navigation measures on the canal will minimize the reciprocal impact nuclear power plant – navigation transport activities. As regards the liquid releases, the inactive chemical monitoring environment program is including the necessary activities in order to meet the regulation requirements regarding both environmental protection and supplementary programs that may be implemented in case of accidental leakage of chemical substances.

Taking into consideration the present situation in the Cernavoda Town, the necessary specialists and workers for the completion and operation of Units 3 and 4 who will live in the town will be integrated easily in the population and will meet people with similar professional profile. They will have a positive impact, stimulating the development of the education system.

The Cernavoda NPP activities are carried out far from components of the cultural, archaeological, historical patrimony and an impact on them is not expected.

9.10. Radiological Impact

The derived emission limits calculated for Cernavoda NPP are conservative; the actual dose that would result from a specified release rate would be less than that calculated.

In order to obtain one more safety measure, those who operate the CANDU nuclear-power plants, will restrict the releases of radioactive material in the environment, by imposing administrative limits.

For Cernavoda NPP, this limit has been established at the equivalent of effluents releases, which could lead to a dose for the persons in the critical group of maximum 5 % from the dose limit of 1 mSv/year.

For a safety operation of Cernavoda NPP, the administrative limits represent a warning level.

Conforming to the Fundamental Norms for Radiological Safety, during the licensing process of a nuclear facility, CNCAN shall define a dose constraint for this facility, value which must not be exceeded during normal operating conditions. CNCAN have defined, in the operating license, the dose constraint for Cernavoda NPP Unit 1.

Since the operating target at Unit 1 (administrative dose limit) represents 50 % of the dose constraint recommended by CNCAN, a good margin is ensured during Cernavoda NPP operation. This option will be also respected during Units 3 and 4 exploitation.

As per the Fundamental Norms of Radiological Safety, releasing into environment of both the liquid and gaseous radioactive effluents can be performed only by meeting the derived emission limits.

As Units 3 and 4 design is similarly with Unit 1, the derived emission limits values for each unit will be the same.

By comparison between the emissions reported at Cernavoda NPP Unit 1 and the derived emission limits, it is found that the emissions reported at Unit 1 are under the DEL values. More than that, at Cernavoda NPP the administrative limits, representing 5 % of DEL are applied.

Under the operating conditions of the four units, although the quantity of radioactive effluents will be four times higher, both the gaseous emissions and the liquid ones will be under the derived emission limits.

The collection of gaseous effluents is made by the ventilation system. The overall ventilation system is so designed that the air circulate from areas with low potential of contamination to areas with high potential of contamination, and finally, after filtering, the air is exhausted through a ventilation stack.

The plant is provided with the gaseous effluent monitoring systems.

According to the existing regulations, an exclusion zone is established around the NPP site. According to the norms, measures are provided to avoid occurrence of permanent residence of population and social-economic activities within the Cernavoda NPP exclusion zone. No settlements and other industrial activities excepting those related to the NPP operation are developing within the Cernavoda

NPP exclusion zone. As per the existing regulations, a low population area is established outside the exclusion zone.

As Unit 3 and Unit 4 are similar to Unit 1 and Unit 2, the maximum dose received by a member of the critical group at operation of the four units will be of 0.20 mSv/year, a value being situated under the dose limit for population (1mSv/year).

Both the design and operation of NPP Unit 1 and Unit 2 provide maintaining of radiation doses outside nuclear buildings under the limit value allowed for public by the regulations in effect. From the presented data, it is found that the doses for the professionally exposed personnel are much smaller than the limits established by norms.

The plant design for Cernavoda NPP U3, respectively U4 has in view the radiation protection of the site personnel, members of the public and environment both in normal operation and accident conditions

During normal operation, the provisions taken by design for radiation protection of the site personnel refer to:

- minimizing the radioactive sources;
- reduction of the amount of liquid impurities;
- keeping activity levels in liquid and gaseous processes low;
- provisions for radiation shielding;
- classification of the areas inside the plant depending on the radiation hazard existing in those areas;
- provisions for contamination protection;
- provisions for hazard warnings: there are provided signs to warn personnel about radiation hazard;
- providing the access control system;
- provisions for a good maintenance;

- provisions for fixed and portable radiation monitoring equipment, contamination monitoring equipment, airborne activity monitoring equipment and liquid process monitoring;
- provisions for personnel facilities, as washing/showering facilities, changing rooms, protective clothing laundry, decontamination facility.

The report presents results of the measurements and analyses performed by ICIM in the year 2004, with regard to the environmental factors radioactivity in locations at different distances from Cernavoda NPP.

Transboundary effects

In normal operation the Cernavoda NPP releases small quantities of radioactive materials to the environment. These releases are closely monitored to ensure compliance with regulatory limits. In practice, the yearly operating target is sub-divided into weekly or monthly targets to better control NPP releases. These limits are well below 5 % of the derived emission limit (DEL), which ties directly to the 1 mSv/year public dose limit. Conservative modelling shows that the highest dose, from four units, to a member of the critical group would be 0.2 mSv/year (0.05 mSv/year each from Units 1, 2, 3 and 4). Although these limits are focused on public radiation protection, they are so low that they have been used to assure environmental protection as well.

Taking into account the reasons mentioned above and related information provided by this assessment, it results that the operation activities of the NPP Units 1, 2, 3 and 4 should have no significant effects in the next neighbourhood of the plant (the critical group are located at about 2 km distance from the Cernavoda NPP) being greatly under both the Romanian and CE norms. As much as the distance to the plant increases, these effects are diminishing, while at distances of about 30-40 km, these effects have no practical significance.

Given the distance between Cernavoda Site and other countries (the nearest country, at around 40 km, is Bulgaria), this study has concluded that no significant adverse transboundary effects should occur.

9.11. Safety Principles Considered in the Design

The safety philosophy of CANDU 6 NPP is based on three main safety principles, namely:

- defense-in-depth;
- ALARA;
- grouping and separation.

The most important goals of the nuclear unit are the attendance of a high level of performance and the assurance of safe operation. These targets are accomplished by means of multiple physical barriers against the radioactivity release to environment and by application of defense-in-depth principle whose requirements are as follows:

- high standards in design process, commissioning and operation have to be applied;
- high quality materials and equipment whose performances were established by testing or analyses should be selected;
- application and strictly compliance of the quality requirements in the design, construction, installation, operation and decommissioning phases should be mandatory;
- attendance of a high level of reliability using redundant systems and components as well as by compliance with the diversity concept both in design and fabrication processes;
- a well defined set of operating policies and principles should be approved and adopted which intent to avoid the reactor operation in potentially unsafe conditions.

Five barriers are identified for CANDU PHWR-600 project (four physical and one administrative) by which defense-in-depth is provided.

The main requirements imposed on design and safety analyses fields should anticipate the potentially failure modes and failures themselves, and shall demonstrate that the nuclear unit is adequately protected.

The nuclear safety objective is to protect the operating personnel, the public and the surrounding environment against the radiological risk. In order to accomplish this, adequate protective means/measures/provisions should be established and maintained. This objective is also the fundamental criterion which nuclear unit safety concept is based on. According to the specific risk associated to nuclear activities, the radiation protection objectives have to be realized such that:

- during normal and abnormal operating conditions the personnel and public radiation exposure shall be maintained below the allowable limits and As Low As Reasonably Achievable (ALARA);
- radiation exposure due to accident conditions should be minimized.

The radiation protection optimization applies wherever the radiation exposure may be controlled using protective measures.

The actual radiation protection strategy is the result of a historical process that reflects the desire to obtain the most efficient radiation protection for public and environment, along with the use of radioactive material on large scale. With this respect, the ALARA principle is the fundamental and decisive factor by which the radiation protection is optimized maintaining the radiation exposure as low as practical attainable, below the allowable dose limits and justified from both economic and social point of view. In turn, this principle derives from the three fundamental criteria associated to systems for radiation dose limiting, that are adopted, settled and identified as follows:

- no activity with radiation exposure should be developed unless a net positive benefit is produced;
- all irradiation should be maintained as low as practical achievable taking into account both economical and social factors (ALARA);
- the total dose equivalent received by an individual should not exceed the corresponding application dose limits.

9.12. Other Authorizations

Some of the installations on the Cernavoda NPP platform that are used in common by all the nuclear units were included in the environmental license for Unit 1. This environmental license was renewed in the year 2005.