

**THE INTERNATIONAL COOPERATION AND PARTNERSHIP,  
KEYSTONES FOR ENGINEERING  
AND PROCUREMENT FOR CERNAVODA NPP UNIT2**

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## **1. Introduction**

Romania is experiencing the second year as a member of the European Union , and is crossing a crucial year in implementing the national energy strategy. The last year European Community documents, as AN ENERGY POLICY FOR EUROPE or THE NUCLEAR ILLUSTRATIVE PROGRAMME, has provided the guidelines for the new Romanian energy strategy, based on the principles of supply security, competitiveness, environment protection and optimization of the use of domestic natural resources. In line with the right of each European state of for choosing the proper energy mix, in order to be able to face the predicted deployment of natural gas and oil resources, Romania has to re-direct its strategy to improve the energy efficiency, to develop renewable energies and to extend nuclear energy use.

Romania has developed the national infrastructure for the implementation, management and operation of the nuclear power projects, including the environment protection aspects. The Ministry of Economy and Finance is responsible for the national power strategy, including NPP projects implementation and operation. Other important actors are the Ministry of the Environment, the Nuclear Agency, the Nuclear Regulatory Body - CNCAN and the National Agency for Radioactive Waste – ANDRAD and, acknowledged Societatea Nationala Nuclearelectrica SA, the operator of Cernavoda NPP.

For Romania, the nuclear energy represents an obvious reality, strongly proved by the following major achievements:

**A.** The high performance recorded by Cernavoda NPP Unit 1 along 12 years of commercial operation:

- Over the year 2007 the Cernavoda NPP-Unit 1 generated an amount of electricity of 6,005,175 MWh, out of which 5,177,077 MWh were supplied to the electric power system. The gross capacity factor exceeded the value of 90.0% for three years in a row. The value of 97.52%, attained in 2007, is the best achievement ever reached by this unit, which placed it among the top units, ranking it the fourth among the heavy water nuclear power stations, and the 84<sup>th</sup> in the world, out of the 427 nuclear power reactors under operation at the end of 2007. Since in service, Unit 1 generated 60,473,402 MWh at an average gross capacity factor of 88.46%

- On September 21, 2007, the Cernavoda NPP-Unit 1 registered 350 days of continuous operation, reaching an average gross capacity factor of 100.26% during the first 8 months of the year 2007.
- high quality of the nuclear fuel produced by Nuclear Fuel Plant in Pitesti – as demonstrated by the 75 consecutive months of operation of the Cernavoda Unit 1 without detecting even a single defective fuel bundle,
- the very good quality of heavy water produced in Romania, at ROMAG – Heavy Water Plant in Drobeta Turnu – Severin, based on Romanian concept and technology ,

**B.** The commissioning of the Cernavoda NPP's Unit 2, on October 5th 2007 - the most recent success of the Romanian nuclear industry:.

Unit 2 coming into operation represents a great performance, with positive effects on the program of the national grid stability and with an important contribution for safety assurance on procurement of energy resources for Romania and European Union as well.

**C.** Completion of the Cernavoda NPP Units 3 & 4, as a new challenge optimistically facing by the Romanian society.

All those represent achievements of entire Romanian economy and society, for which the education, research, design engineering and operation of these nuclear objectives equally contributed, proving the professionalism and dedication of all those involved.

Societatea Nationala "Nuclearelectrica"(SNN) S.A. has been established in 1998 as a state owned company (Romanina State owns 90,72% of the shares and 9,72%. are owned by Private Investement Fund "Proprietatea") is reporting to the Ministry of Economy and Finance.

SNN SA represents the Romanian National Company that operates Unit 1&2 and has the responsibility of administration and preservation, until completion and commissioning of Units 3, 4 and 5 at Cernavoda NPP, through its subsidiary CNE Cernavoda and is managing the activity of Nuclear Fuel Plant in Pitesti, its second subsidiary.

Its mission is to generate electricity and thermal power using nuclear technology, to develop nuclear power and to manufacture nuclear fuel, ensuring high safety, economic efficiency and taking care of people and environment.

For 2008, SNN SA's goals are to enlist a stock package on the stock exchange market and to establish a Project Company together with selected foreign investors that will be responsible for the construction, commissioning and operation of the Cernavoda NPP' Units 3 and 4.

## **2. Cernavoda NPP experience**

The first nuclear unit in Romania began its commercial operation in 1996 and the second one was inaugurated in October 2007.

In the last quarter of 2007, both of the Cernavoda units covered about 13% of the electricity needs of the country. For the current year, the nuclear share is expected to increase to about 18%, reducing the carbon emissions accordingly.

The two operating units use CANDU technology (Canadian Deuterium Uranium) and operate with natural uranium fuel, mined and processed in our country and heavy water – as moderator and cooling agent – also manufactured in Romania.

At the end of the year 2007, the company successfully placed itself on the fourth position in the top of heavy water nuclear reactors worldwide. It was also perceived as a trustworthy business partner in Romania and abroad. A record production of 6,961,161 MWe was achieved in 2007 at an average capacity factor of 95.5%. SNN SA is also an active player on the Romanian electricity market, delivering 2,282,619 MWe in transactions in 2007.

These are results of organizational effectiveness, performance improvement, operational, work management, engineering, maintenance as well as radiation protection and industrial safety achievements.

*The plant was designed to have five similar units. The studies performed for the plant, before starting the construction, established the feasible technical solutions for all problems related to a 5-units plant, including the environmental impact, which would be entirely acceptable.*

*The construction works for the first unit started in 1980, and for units 2-5 in 1982. The challenges encountered during the construction of Unit 1 (import restrictions, delays etc.) restrained the progress at Unit 2. Starting with 1990, the work on Cernavoda site was focused on Unit 1 and, practically, the construction at the other units was suspended; for many years, only preservation works were carried-out.*

*In 1995, the works re-started on Unit 2, under the management of the AECL-ANSALDO Consortium. Some progress works were carried-out (e.g. installation of the fuel channels) and a thorough assessment was performed on the condition of the equipment procured for Unit 2 and stored on site, or of the equipment already installed.*

*The absence of a clear contractual framework and the lack of resources significantly hindered the progress of the construction works on Unit 2.*

*Over the last period, many economical estimations predicted that, starting with the winter of 2005, when the internal electricity consumption was expected to increase with about 1,000 MW, the annual electricity production would become insufficient and would not be covered unless Unit 2 of Cernavoda NPP was commissioned. Under these conditions and considering the relatively low cost of the electricity, produced by the Cernavoda NPP's Unit 1, versus the cost of energy supplied by conventional thermal power stations, the Romanian Government started to assume a great support to the completion of the Cernavoda Unit 2 project.*

*In the year 2000, the Government decided that the completion of Cernavoda Unit 2 was a high priority and financed it partially.*

*The reference design for Unit 2 was the "as built" of Unit 1, with a certain number of improvements.*

*A number of changes aimed at meeting the new regulation, by providing the increase in the margin of safety or at improving the operation reliability, in accordance with the development of the nuclear technology. Other minor changes, improved the system or station performance, or replaced the obsolete equipment.*

### 3. Cernavoda NPP Unit 2 Completion and Commissioning Process - step by step

Unit 2 Completion and Commissioning Contract signed between SNN SA, AECL and ANSALDO come into force on March 24, 2003, after the foreign loan agreements had been signed in December 2002 with Groupe Societe Generale, for financing procurement of goods and services to be supplied from Canada, Italy and France, and in February 2003 with Societe Generale New York and Exim Bank USA for financing procurement of goods and services from US.

- At the end of 2003, the Cernavoda NPP Unit 2 was built in proportion of 54.1%, the works on Unit 2 project being performed mainly in the areas of Engineering & Design, as support for C&I works and procurement works; C&I works: civil works, material and equipment installation, electric equipment and • Manufacture of equipment and materials in the country and abroad.
- At the end of 2004, Cernavoda NPP Unit 2 was built in proportion of 77.2%. During the first half of the year, the major activities were focused on Engineering and Procurement while during the second half, the works continued mainly with Construction and Commissioning. Thirteen systems were turned over to commissioning in the established sequence, which represented a significant achievement for the Project. A refurbishment program was also implemented for materials and equipment procured before 1990. In this regard, different components (gaskets, relays etc.) were procured for replacement. The program also included the assessment of documents like History Documents, Safety and Licensing and Current Codes and Standards.

On March 30, 2004 the European Commission (EC) approved an EUR 223.5 million EURATOM Loan to finance the completion and safety upgrade of the Cernavoda NPP's Unit 2. The Loan was drawn in several portions and was applied primarily to finance any measures resulted from the recommendations made in the Nuclear Safety Evaluation Report and Environmental Impact Assessment Study, carried out by independent consultants.

The EC supported the preparation of these studies through Community funds.

Following the ratification by the Romanian Parliament of the Guarantee Agreement and the fulfillment of contractual conditions, the Loan came into force on November 26, 2004.

- At the end of 2005, the Cernavoda NPP Unit 2 was built in proportion of 90.2%.

In 2005, an important number of technological systems reached the completion phase, respectively 154 systems were completed, which means that 50% of the plant was undergoing the commissioning tests phase.

The detailed design was completed and, further, the work was focused on solving the site dispositions and on the implementation of some design changes, with minimal impact on procurement of new equipment and material.

Additional quantity of equipment and materials identified as necessary following either the completion of the detailed design or following some invariable failures of the equipment and materials stored in warehouses or erected before the Completion Contract coming into force, were purchased based on the Addendums to the supply contracts concluded with the main suppliers (AECL - Canada, ANSALDO - Italy, NEXANS - France and GENERAL ELECTRIC - SUA).

- At the end of 2006, the Cernavoda NPP Unit 2 was built in proportion of 98.2%.

All the important systems reached the completion phase, which allowed the complex tests to start for large groups of systems. So, during the last four month of 2006, several important steps, specific to the commissioning stage, were completed:

- The heavy water was loaded into the moderator circuit
- The structure integrity and leak rate test were performed on the reactor building
- Hot conditioning test was performed on the primary heat transport circuit.

The transfer process of the critical systems, facilities and areas to the commissioning team also continued, reaching the number of 151 transferred systems, by the end of December 2006.

- The final phase of Unit 2 completion:
  - May 6, 2007 - hours 23:25:25, first criticality of the reactor
  - August 7, 2007, hours 17:21, the first synchronization of Unit 2 with the national power grid.
  - September 12, 2007, 03:57, the reactor of Unit 2 reached full power
  - September 28, 2007, the management of Unit 2 was turned over to SNN SA

#### **4. Cernavoda NPP Unit 2 - experience related to training of personal**

According to the contract signed in May 2001, between SNN S.A. and AECL and ANSALDO, a "Management Team", formed by representatives and specialists from Canada - AECL, Italy - ANSALDO and Romania - "Nuclearelectrica" was in charge of the engineering, procurement, construction and commissioning processes for Cernavoda NPP's Unit 2.

More than 1,600 workers were employed by the "Management Team" of which 110 were AECL experts from Canada, 80 ANSALDO employees from Italy and 700 were "Nuclearelectrica" permanent employees.

A similar organization was successfully applied to Unit 1 Project.

Their main activities related to Unit 2 commissioning and initial operation were focused on systems commissioning, preparation of commissioning procedures and commissioning reports (like Commissioning Completion Assurance Reports), preparation of operating documentation, assessment of documents (like History Documents).

After the turnover of Unit 2 from the "Management Team" to "Nuclearelectrica", in 2007, the U2 operation was integrated into a "Two-Units" organization (together with U1).

Unit 2 integration was carried-out gradually, beginning with the construction stage and ending with the commercial operation in 2007.

The first step was the development of the "Two-Units" Organization Chart, taking into account the experience gained from Cernavoda NPP Unit 1 and from similar nuclear plants operation, in order to avoid parallel activities and doubling responsibilities.

Thus, Unit 1 and Unit 2 are sharing a part of the existing staff of Unit 1 (technical services personnel, training personnel etc.) and many of the common station services.

Only operation personnel and a few groups of maintainers, chemical technicians and fuel handling operators are specially dedicated to Unit 2 operation.

Then, the next step was to hire staff, to fill up the new positions, according to the identified needs. The new employees received general training and were assigned to Unit 1 departments to receive on-the-job training, according to the defined job requirements and qualification. Together with a number of experienced staff of Unit 1, they were transferred to the Management Team, at different stages of Unit 2 Project

completion, to carry out the commissioning and initial operation activities. After the turnover of Unit 2 from the Management Team to SNN S.A., they were assigned to their positions, on the Two-Units Organization Chart.

### Recruitment Process

The Unit 2 staff recruitment process was based on two sources:

- Recruitments from outside of SNN S.A.;
- Transfer from the Cernavoda NPP Unit 1.

The graduates of the Bucharest Polytechnic University, especially of the Nuclear Power Faculty, are a source for recruiting personnel from outside SNN S.A.. SNN has maintained close relations with the Bucharest Polytechnic University and has financed several scholarships for students each year. After graduation, these students have started to work as permanent employees at Cernavoda NPP.

About 100 experienced employees have been transferred from Unit 1 to support Unit 2 commissioning and operation. They have gained experience during Unit 1 systems commissioning, systems operations, preparation of commissioning procedures, technical information reports, commissioning reports etc. All of them have been trained within the Cernavoda NPP Training Department. Many of them have also been trained in specific job functions for Unit 1 commissioning and operation, by assignments to the Point Lepreau station in Canada during 1992 / 1993.

Control Room Operators and Shift Supervisors have been recruited from Unit 1 operation staff. A number of non-licensed operation positions have also been filled up with experienced nuclear operators from Unit 1.

### Training and Education Process

According to Cernavoda NPP training policy, Unit 2 staff shall be qualified for the required tasks. Training programs are performance based oriented and linked directly to tasks that an individual is expected to perform as part of his job.

The training activities for Unit 2 personnel are addressing the essential capabilities and qualifications to support plant commissioning and operations.

Training needs for Unit 2 personnel have been identified based on Table Top Analysis performed for similar jobs at the Cernavoda NPP's Unit 1.

Training programs implementation started in 2002, when the first 250 persons were hired for commissioning and operation.

About 350 persons are being trained within the Cernavoda NPP Training Department and Unit 1 facilities for U2 commissioning and operation. At Unit 2, lecturers from "Ovidius" University-Constanta and Bucharest Polytechnic University were also involved in personnel training programs.

The training program has been focused on:

- Systems specific training on design differences between Unit 1 and Unit 2;
- Simulator training on operator response to major transients and abnormal operating procedures, followed-up by an internal and regulatory body practical evaluation before the Manual Fuel Load;

- Practical training related to Unit 2 Control Room panel configuration, systems test and operation in commissioning phase.

The training program for Unit 2 field operators have taken advantage of the training and experience gained in Unit 1 operators training. On-the-job training covers essential operator skills and elemental systems knowledge.

A main part of the on-the-job training program has been carried out in Unit 1 Operation Department, under the guidance of experienced operators, using the existing training materials. In addition, the training program has included training on design differences between Unit 1 and Unit 2, for which training materials were developed.

Unit 1 simulator was used for Unit 2 operator's simulator training and also for examination by regulatory body.

#### Continuing training

The purpose of Unit 2 personnel Continuing Training Program is to maintain and improve employee's job performance and to develop their position-specific knowledge and skills.

Continuing Training Program have covered re-qualification for any qualifications that have a specified lifetime, refresher training to maintain and improve skills, industry operating experience, performance problems, plant systems/equipment modifications and procedure changes, identified weakness in training content or delivery.

#### Contractors training

Contractors and temporary personnel who work independently at the plant have been trained and qualified to perform assigned tasks.

All contractor personnel have taken a basic training program including: basic knowledge about plant layout, the basis of plant operation, station organization and administrative procedures, which govern its day-to-day operation. In addition, the program provides an introduction to both conventional and nuclear safety, the quality assurance program, the requirements for radiation protection and actions in the event of an emergency situation on site.

### **5. Procurement Process for Unit 2**

The Cernavoda NPP Unit 2 completion and commissioning process is a result of a real and efficient cooperation at national and international level as well..

In the nuclear sector, the high technologies applied in construction, commissioning and operation of nuclear power plants, with a view to observing the safety principles required by the Regulatory Body ask for the necessity of procuring goods, services and works from certain suppliers, specialized and qualified mainly as nuclear suppliers.

SNN SA, as the owner and operator of the Cernavoda Nuclear Power Plant's Unit 1&2, is constrained to comply with the nuclear safety and licensing requirements resulted from the Romanian legislation and international rules and practices applied for procurement on nuclear market, as well as with all regulations, rules, guides and procedures established by the Regulatory Body – CNCAN and those issued by the governmental organizations with respect to public procurement, custom clearance and control regime of import and export of special nuclear materials.

Operation of Unit 1 & Unit 2 and further U3 to U5 construction and commissioning phase will be beneficially for maintaining traditional Suppliers at least those from outside Romania. During procurement process, there are applied specific procedures for the acceptance of new suppliers and for maintaining qualification of the accepted suppliers.

Suppliers from outside Romania can be accepted if they have a Quality Management Program (QMP), based on ISO or other International or National Quality Standards, but only based on evaluation of the program in comparison with the applicable internal Regulations - Norms for Quality Management – NMC- and establishing supplementary clauses at the level of the contract for the requirements which are not covered by the addressed standard.

In the commercial relationships that SNN SA is developing with its national and international business partners, the demands are focused on choosing qualified manufacturers and suppliers, able to fulfill the quality, price, delivery terms and technical specifications for the products and services required in the nuclear field.

The experience gathered in about 12 years of operation of Unit 1 and about 8 months of Unit 2 at the Cernavoda NPP shows that the aspect regarding the quality of the installed components is the most important issue: to fulfill nuclear safety requirements, ensuring the safe operation of nuclear units.

All our suppliers are expected to act with integrity, to adhere to high standards of ethical behaviour and to operate in the best interests of SN Nuclearelectrica.

For those reasons, SN Nuclearelectrica addresses the purchase orders for procurement of parts and services for completion and commissioning and also for the operation period of Unit 2, to its traditional suppliers, mainly the same as for Unit 1, as few examples below:

- from Canada:
  - AECL Canada for:
    - Services for Fuel Channels Installation, similarly as for Unit 1, Calandria vessel of equipment has also been imported from Canada, through AECL
    - important parts of the components and spare parts required for equipment and systems for nuclear island
    - specialized services for engineering, testing and inspections in nuclear island
  - CAE- Canadian Aerospace Equipment – actually integrated in L-3 Communications – Dual Central Computers DCC – main room process computers
  - Babcock & Wilcox - Pressuriser 3332 TK1 and the Condenser degasser 3332 TK2
  - Valcor, Sartrex, Tyoga, Velan – valves and electrical and electronic equipment
  - 
  - USA - General Electric – supply of major parts of Turbine Generator Equipment - Electric Generator and some parts for Turbine
    - services for installation and commissioning of Turbine-Generator group and post commissioning as well
  - France – Alstom Power - supply of two Stand By Diesel Generators – from
    - Nexans - supply of the power cables, control and instrumentation cables qualified for nuclear radiation

## 6. International Cooperation

Cernavoda NPP completion and commissioning of Units 1&2 is a result of a fruitful cooperation between Romanian organizations involved in the nuclear field and various international specialized organizations and entities.

“NUCLEARELECTRICA” SA is an active member of WANO-Atlanta Center (World Association of Nuclear Operators), COG (CANDU Owners Group) and Electric Power Research Institute (EPRI), benefiting from a continuous exchange of experience in the field.

SNN SA -as power producer- is also member of EUELECTRIC – through IRE – National Romanian Institute for management of Energy Sources.

The Romanian companies involved in nuclear program developed also an effective and extensive partnership within IAEA European regional cooperation programs, Joint Research Center programs, European Commission Framework Programs, research laboratories.

### **Conclusions**

- Nuclear power is part of the energy policy promoted by the Romanian Government to develop the nuclear energy as part of the European policy, considering (1) sustainable development, (2) security of energy supply and (3) competitiveness.
- Romania has the necessary infrastructure to successfully acquire, construct, commission and operate nuclear power plants;
- Coherent national nuclear safety policy, consistent with the European initiatives, represents a strong guarantee for a reliable nuclear power program;
- The Romanian Nuclear Power Program has an important international dimension, representing a good example of cooperation with partners from Europe and North America
- The private investors will play an important role for the future of nuclear power in Romania.