

## **YOUNG GENERATION IN ROMANIAN NUCLEAR SYSTEM – ROMANIAN NUCLEAR ORGANIZATIONS IMPLICATION IN NUCLEAR KNOWLEDGE MANAGEMENT AT UNIVERSITY “POLITEHNICA” OF BUCHAREST: RESULTS AND EXPECTATIONS**

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Abstract. The knowledge management should be assumed by the major players within the nuclear community: government, industry and university.

Starting from these problems this article gives an overview about Romanian nuclear knowledge management and the Young Generation implications.

In Romania there are many government and non-government nuclear institutions such: CNCAN (Romanian Regulatory Body), ROMATOM (Romanian Atomic Forum), AREN (Romanian "Nuclear Energy" Association), and companies: SNN (“Nuclearelectrica” SA National Company), CITON (Centre of Technology and Engineering for Nuclear Projects), SCN (Institute for Nuclear Research), ROMAG - PROD (Romanian Heavy Water Plant).

All these institutes and companies are sustaining the national nuclear program and promoting the new technologies in the nuclear industry according with CNCAN and ROMATOM regulations.

University “POLITEHNICA” of Bucharest - Power Engineering Faculty – through Nuclear Power Plant Department is the promoter of nuclear knowledge management. It is implied in assuring and maintaining a high – quality training for young staff.

Young Generation is implicated in nuclear knowledge management through University “Politehnica” of Bucharest - Power Engineering Faculty – Nuclear Power Plant Department and AREN (Romanian "Nuclear Energy" Association).

Young Generation Department has special educational programs for attracting and supporting students. It provides adequate information and interacts with potential students.

Moreover the article gives results about Romanian nuclear engineers since 1970 till now. An analysis of these data is done.

Also it is discussed how University “Politehnica” of Bucharest, the Romanian Government and the Industry work together to co-ordinate more effectively their efforts to encourage the young generation.

### **1. Introduction.**

The use of nuclear technology relies heavily on the accumulation of knowledge – both technical information in documents and databases and knowledge in people: scientists, engineers, and technicians.

The effective management of nuclear knowledge includes ensuring the continued availability of qualified personnel. Moreover, it is critical to ensuring safety and security, encouraging innovation, and making certain that the benefits of nuclear energy remain available for the young generation.

The nuclear workforce is ageing and fewer people are studying nuclear science and nuclear engineering at the university levels.

The nuclear workforce renewal includes both – the current understand of the problem and, the response and corrections of these trends. Therefore, governments, industries, research

institutes and universities need to work together to co-ordinate their efforts to encourage the younger generation to choose the nuclear fields.

## 2. Nuclear knowledge management in Romania.

One of the purposes of Romanian integration into the European Union is the correlation between national development goals and European experience achieved in the field of human resources and young generation development.

Therefore, the nuclear energy evolution, in accordance with IAEA requirements, implies technical and scientific knowledge level compatible with the international level development, with the young generation involvement.

Likewise, it is necessarily experts with European knowledge level provided to handle the Romanian nuclear equipment and devices problems and, on the other hand, to have the competence to assimilate new technical and scientific information.

## 3. Romanian nuclear organizations

*CNCAN (Romanian Regulatory Body)* has the authority to deliver nuclear authorizations and licences, according with Romanian guidelines; to control the enforcement of the law according with nuclear safety requirements; to license the nuclear power plants emergency plans and to participate in a nuclear accident case; to license the nuclear projects; to inform the Ministry of Environment and Water and The Ministry of National Defence about any event that could cause a significant radioactivity increase; to collaborate with international organizations on the purpose of promoting Romania's nuclear interests with IAEA and NEA relationships.

*ROMATOM (Romanian Atomic Forum)* is the Romanian legal entity of private law since January 10, 2001. ROMATOM is an independent association with national representation, a non – governmental, non – profit and apolitical association.

The main scope of ROMATOM is the generation of electric and thermal power through nuclear processes in compliance with Romanian laws in force. Moreover it sustains the research in the electrical power field generally and in the nuclear field especially, the research in the nuclear physics domain, the nuclear power field related activities, representing the “voice” of national nuclear industry.

The main purpose of the ROMATOM is the peaceful use of the nuclear energy in Romania and the sustainment of the national nuclear program.

ROMATOM's mainly activities are:

- Contacts and meeting with Romanian and European political personalities;
- Participation in organization of the major nuclear events in Romania;
- Set – up ROMATOM national working groups: Quality management, National Nuclear program surveillance; Nuclear Safety Standards, Decommissioning Funds.
- Issuing, jointly with AREN (Romanian "Nuclear Energy" Association) of the “Energia Nucleara / Nuclear Energy” magazine and “Stiri Nucleare/ Nuclear News” bulletin

ROMATOM's 2004 strategic objectives are:

- Active presence in preparing and implementing the decisions related to the Romanian National Nuclear Programme;
- Sustaining and promoting in Romania national nuclear industry, research and engineering interests;
- Promoting the nuclear energy peaceful utilization;
- Public confidence's increasing in the Cernavoda NPP's nuclear safety;
- Development and information's exchange with similar national and international organizations

- Coordination of the activities resulted from ROMATOM's affiliation to the European Atomic Forum – FORATOM.

*AREN (Romanian "Nuclear Energy" Association)* began its activity in 1990. In our days the association has more than 250 individual members and over 10 collective members from the Romanian industry and from University "Politehnica" of Bucharest.

The main goals of AREN are: to inform the officials, local administration and general public about nuclear power and its development; to promote new modern technologies; to provide support for the national nuclear.

AREN has activities as a co-organizer to the major nuclear events next to ROMATOM and other non-government organizations such as: SIEN (International Symposium on Nuclear Energy), Nuclear Power Days, Scientific Seminars. Moreover it has activities for attracting new members and for collecting the outstanding due.

A new an important department in AREN – Young Generation Department – has been extended this year. Formed, at the beginning, as a young section, YG Department has these days more than 50 members from University "Politehnica" of Bucharest, CITON (Centre of Technology and Engineering for Nuclear Project), SNN ("Nuclearelectrica" SA National Company), and NPP Cernavoda.

YG was involved in the SIEN and Nuclear Power Days organization. Moreover AREN – YG Department has participated at the international conferences: Nuclear European Conference, Nice 1998; International Youth Nuclear Congress, Bratislava 2000, International Youth Nuclear Congress Daejeon 2002. Moreover YG became in 1998 ENS – YG member and there is a permanent communication between the organizations.

YG's 2004 - 2006 objectives are:

- Participation at the government's and non - government's activities that have an interest in the nuclear field;
- Informing the young public in matters regarding the nuclear field;
- Publishing articles in the national and international magazines;
- Up-dating AREN's web site: <http://www.aren.ro> by implementing a new webpage – for YG department;
- Co-organizer at SIEN 2005 and 2007;
- New exchanges with international nuclear societies.

*SNN ("Nuclearelectrica" SA)*, is registered with the Register of Commerce, Chamber of Commerce and Industry since July 27, 1998. SNN – SA is reporting to the Ministry of Industry and Trade and the state owns 100% of the shares.

SNN – SA has three branches, no legal person:

- "CNE PROD" which includes Cernavoda NPP, Unit 1 and the auxiliary services;
- "CNE INVEST" which includes Units 2 to 5 from Cernavoda site.
- "FCN – Pitesti", the Nuclear Fuel Plant.

The main objectives of SNN are:

- to maintain the Cernavoda NPP Unit 1 at full power within the limits required by licensing documents
- to attract domestic and foreign capital and financing for the completion and commissioning of Unit 2
- to produce CANU 6 nuclear fuel;
- to participate in the nuclear power development program in Romania.

In the field of human resources SNN – SA selects trains and licenses its employees relative to technicality, complexity and importance of equipment and facilities. Moreover, SNN provides practice training for maintaining the mental condition and capability and job culture allowing skills development necessary to deal with the modern work instruments and devices.

SNN – SA has adhered to international specialized organizations such as: IAEA (International Atomic Energy Agency), COG (CANDU Owners Group), WANO (World Association of Nuclear Operators) and is part of several international agreements at governmental level with Canada (AECL), Japan (JEPIC), Argentina (CONEA).

*CITON (Centre of Technology and Engineering for Nuclear Projects)* is the only one specialized and certified to perform design and engineering services for nuclear projects in Romania. Based on more than 30 years of experience CITON's main activities are:

- Support design documentation;
- Safety operation monitoring documents;
- Pre-commissioning and in – service inspections;
- Consulting, engineering and technical assistance;
- Programs for operating and maintenance personnel and training tools;
- Radioactive waste management;
- Economic evaluation and cost analyses;
- Computer assisted design programs;
- Decommissioning engineering activities;

CITON has co-operation both with national companies such as: CNE – Prod, Institute of Nuclear Research (SCN), Heavy Water Plant, and international companies like: AECL (Italy), General Atomic (USA) PEC (France) SGN (France), SKB (Sweden).

*SCN (Institute for Nuclear Research)*

SCN, located in Pitesti, has developed technologies, methods, computer codes for its own experimental infrastructure. The research activity of the institute is oriented with priority towards applied and engineering research within programmes with objectives connected to present and future specific issues of a CANDU NPP. Moreover, the institute is involved in the management of radioactive waste, and today is the only institution in the country with multiple capabilities concerning applied technologies, which cover radioactive waste area, from production to the final storage.

The institute, likewise, has had a well – qualified source of highly trained personnel for employment in NPP. This happened due to the previous research activity of the institute, when university graduates were employed and trained and prepared within the institute and abroad.

The future of the institute is again linked to the cooperation with universities and state officials to be able to become a source of national competence, a challenging support for the nuclear programme.

*ROMAG - PROD (Romanian Heavy Water Plant)* produces heavy water for CANDU type reactors. It has the largest producing capacity in the world.

The Plant was built between 1980 – 1988 and the first production line was put in operation on July 1988.

The heavy water is obtained from Danube River, which contains 0.0143% deuterium. This water is separated and concentrated in ROMAG's equipment and installations up to a minimum nuclear concentration of 99.78%. Moreover ROMAG produce heavy water with a concentration of 99.96%

The heavy water generated at ROMAG – PROD corresponds to the international standards requirements and it is ISO 9001 and ISO 14001 licensed. Therefore, since 2001, ROMAG exports heavy water for South Korea NPP.

*Power Engineering Faculty from University "Politehnica" of Bucharest* is the only faculty in Romania acting in the nuclear high education. This activity begun in 1967 with the first course of "Nuclear Power Plants". The first specialized class graduated in 1967, and in 1970 the foundation of the Nuclear Power Plant Department was approved.

Since then the department had a continuous enlargement – both in the teaching activities and scientific work. Moreover, the nuclear power plant department has been opened for young nuclear assistant - professor generation.

Young assistant – professors and students are AREN’s members and there is an important co-operation between our YG department and AREN’s YG – department.

According with EU requirements since 1997 in our university credits system has been set. This system has offered students the possibility under a professor close guidance to choose between several courses for his/her best training.

In our department, the speciality courses, which could be chosen by students starting with the 6th semester, are:

- Nuclear reaction and nuclear fission theory( in the 6<sup>th</sup> semester);
- Nuclear materials ( in the 7<sup>th</sup> semester);
- Nuclear systems thermal hydraulics (in the 7<sup>th</sup> semester);
- Nuclear Power Plants I ( in the 7<sup>th</sup> semester);
- Nuclear Power Plants – Modelling and Simulation ( in the 7<sup>th</sup> semester);
- Nuclear reactor engineering ( in the 8<sup>th</sup> semester);
- Nuclear reactor theory I ( in the 8<sup>th</sup> semester);
- Dosimetry and Radiation protection ( in the 8<sup>th</sup> semester);
- Electrical part of NPP I ( in the 8<sup>th</sup> semester);
- Nuclear Power Plants II ( in the 9<sup>th</sup> semester);
- Nuclear reactor theory II ( in the 9<sup>th</sup> semester);
- Electrical part of NPP II ( in the 9<sup>th</sup> semester);
- Nuclear Safety ( in the 9<sup>th</sup> semester);
- Control systems of NPP ( in the 9<sup>th</sup> semester);
- Reliability in power engineering ( in the 9<sup>th</sup> semester)

Since 1970, in the nuclear power plant department graduated 900 students as is showed in the figure 1.

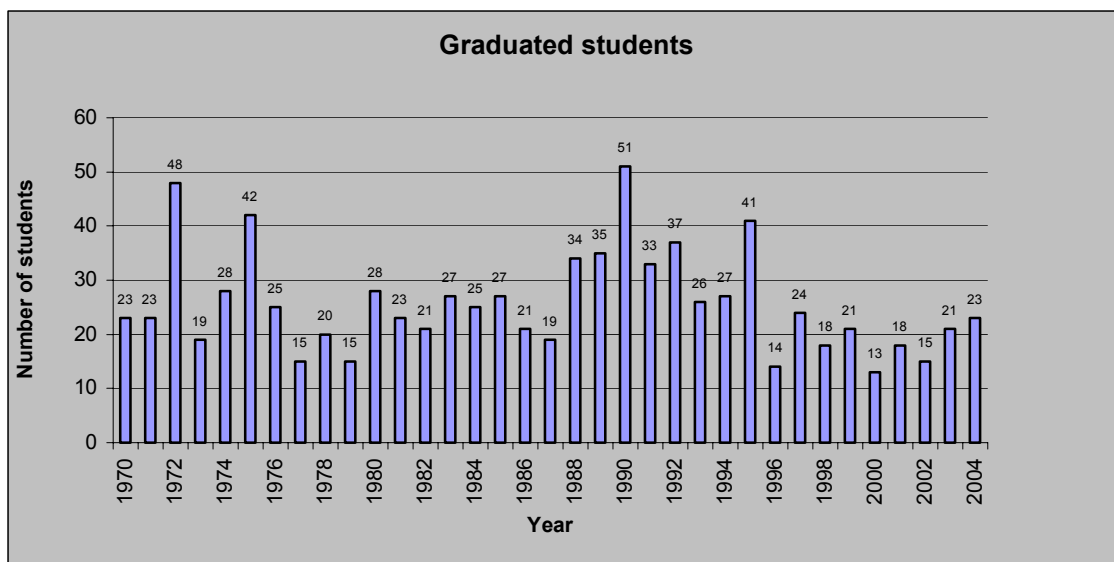


FIG. 1. Number of graduated students in nuclear power plant department

In the concordance with EU and USA education systems, in the present, it is discussed a new education system organization with 4 year of training for the bachelor diploma and 1 year

extra for the students with an average greater than 7 /10 for obtaining the diplomatic engineer diploma.

At the end of this 5 years of training students can continue their high education with short (1 year) / long (2years) master and then with PhD stages.

Moreover, Romania through UPB – Power Engineering Faculty – Nuclear Power Plant Department and CITON are members in ENEN (European Nuclear Engineering Network) and NEPTUNO (Nuclear European Platform of Training and University Organizations) Associations. ENEN was developed in FP – 5 between 2002 – 2003. ENEN has tried to better integrate European education and training in nuclear engineering and safety. NEPTUNO is developed in FP – 6 between 2004 – 2005 and propose appropriate and affordable solutions for the member state institutions involved in education and training.

The short master in the field of Radioprotection and Nuclear Safety was set up in 1998 according with the EU requirements, in the cooperation with universities and nuclear research centres from Belgium (SCK – CEN, Mol), Spain (CIEMAT), and Italy (University “Politecnico” of Turin).

On the both semesters of studying the master students are taking the following courses:

- Particular theories in nuclear process;
- Particular processes in nuclear reactor theory;
- Particular processes in NPP - thermal hydraulics flows ;
- Nuclear power plants – special problems;
- Nuclear safety – specific requirements;
- Radioprotection;
- Dozimetry;
- Special problems for NPP reliability.

Since its beginning, in 1998, till 2004, in the Radioprotection and Nuclear Safety master graduated 58 students, like is shown in the figure 2.

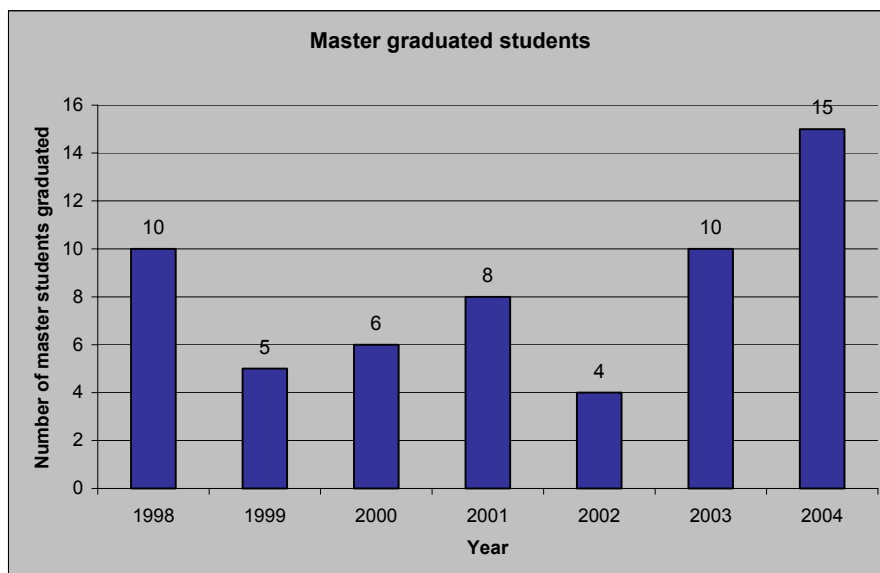


FIG. 2. Number of master graduated students in nuclear power plant department

As a result of a good collaboration through our department, SNN and CNCAN have started from February 2000 for a period of 9 months per year training periods for the NPP Cernavoda employers in the field of:

- Thermal processes in NPP;
- Nuclear reactor theory;
- Nuclear materials;
- Control and devices in NPP;
- Hydrodynamic processes in NPP;

Moreover, with CITON in July – September 2000 have been performed courses in the field of “Modelling and Simulation of nuclear processes in NPP” and “ACSL and MMS training code utilization”.

#### 4. Conclusions.

To encourage the younger generation in the nuclear field, universities, industry and research institutes need to work and collaborate together.

Universities should provide basic and attractive educational programs; interact early and often with potential students; provide early research opportunities and adequate information.

Industry should continue to provide rigorous and high – quality training programs that are needed for employees and research institute should attract the young graduated students with exciting research projects.

Last but not least the governments should sustain a healthy nuclear enterprise, provide adequate resources for vibrant nuclear research and development programs, and support young students.

Therefore the good collaboration through University “Politehnica” of Bucharest and the government and non – government organizations will contribute to the professional competence growth and it will provide nuclear safety in according with the IAEA requirements. Moreover it will provide support for the industry and research determining factors from the government and regulation organizations ensuring the human resources necessary for the nuclear safety required, both – in the present and in the future.

In this way, as is showed in figure 3, through the industry – research – universities links it is provided the employers skills conservation and also the young generation knowledge transfer; between the old generation who pus the bases of nuclear science and the new generation who will provide the continuation of it.

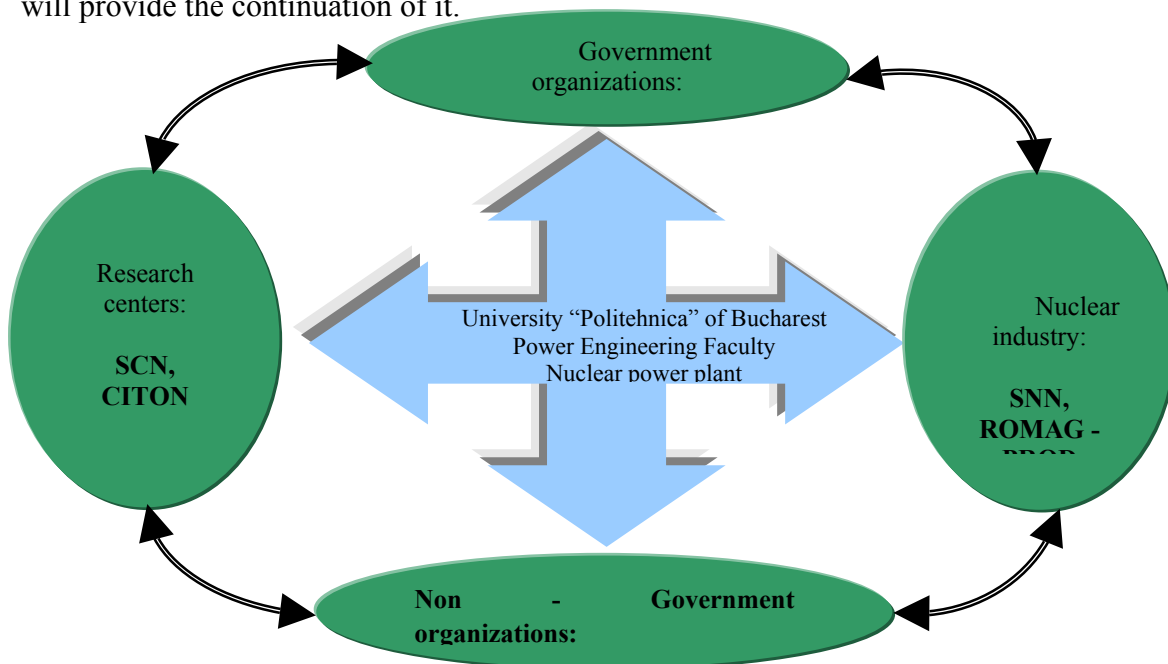


FIG.3. University “Politehnica” of Bucharest – government and non – government organizations – research centres – nuclear industry links

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