1. Introduction

This work is intended as a general presentation of the educational system and research field, with reference to nuclear sciences, and the legal system, with reference to requirements established by the regulatory body for the professional qualification and periodic training of personnel involved in different activities from the nuclear field. Thus, in part 2 and 3 of the work are presented only public information regarding the education in nuclear sciences and nuclear research in Romania; in part 4 are slightly detailed the CNCAN requirements for the personnel training, specific to nuclear activities; part 5 consist in few words about the public informing activities in Romania; and, part 6 tried to draw a conclusion.

2. Education in nuclear sciences

The nuclear education begins in Romania in the gymnasium. Up to now, the first 8 grades were obligatory and gratuitous; for this year, the first 10 grades will be obligatory and gratuitous. The study of physics starts in the 6th grade, the first notions of nuclear physics being introduced in the 8th grade. With the condition to realize the objectives stipulated by the educational syllabus and the totally covering of the obligatory content, the teacher has the liberty to distribute the contents in the hours allocated by the educational plan as he considers necessary, to establish the order of themes, and, according to the class level, he may develop some extensions of the obligatory themes. Thus, the obligatory nuclear physics contents of the physics educational syllabus for the 8th grade are: “Radiation and radioprotection” and “Nuclear power engineering”, with subjects as “X and gamma, alpha and beta radiations” and
“Nuclear power plants”; extension subjects of these chapters are: “Biological effects and radioprotection”, “Nuclear weapons” and “Nuclear accidents”.

The study of nuclear physics continues in high school, at different levels, according to the high school profile. The nucleus physics chapter of the physics syllabus contains obligatory themes ranging from nucleus constituents, nuclear forces, natural and artificial radioactivity, to nucleus stability, radioactivity, radioactive disintegration law, interactions between radiations and matter, nuclear radiation detection, dosimetry, nuclear fission, nuclear reactor, nuclear fusion, with extension subjects such as particle accelerators and elementary particles. The specific competencies envisaged by the nuclear physics chapter of the physics syllabus are: the identification of notions and concepts necessary to formulate the atomic nucleus theory, solving simple problems, explaining on the modelling basis of some aspects related to nucleus structure and stability and radioactive disintegration, discussions about nuclear physics discoveries impact on the natural and social environment.

For young people interested in continuing the study of nuclear physics there are several physics faculties within the state universities (of Bucharest, Constantza, Craiova, Cluj, Iasi, Timisoara) or private physics faculties (being at present in different stages of accreditation). All these faculties offer different sections (such as physics, technological physics, medical physics, environmental physics and informatics physics) and different specializations. During the first studies cycle, all the students (of all the faculty sections), attend a general course on nuclear physics theory. At the end of the 3rd year, the students can choose among several specializations for the next 2 or 3 years of training. Founded in 1967, the Physics Faculty of Bucharest University is the only one who offers an Applied Nuclear Physics specialization and a Nuclear and Elementary Particles Interactions specialization. The students training is assured by teachers internationally recognized for their research activities and co-operation with prestigious institutions (NEA DB Paris, IAEA Vienna, PTB Braunschweig, IUCN Dubna, CERN Geneva, KEK Tsukuba, Jlab USA etc.). By the structure and the quality of information transferred, the graduates of these specialization sections are formed as very good specialists in this field. The themes of proposed courses cover all the necessary knowledge for a nuclear physicist engineer: experimental methods, data acquisition systems, processing, calculating, simulation and assessment methods, nuclear structure and interactions models, nuclear spectroscopy, nuclear fission and fusion, nuclear radiations applications, nuclear reactors physics, environmental radioactivity, dosimetry, radioprotection and nuclear management, calculation codes and nuclear
databases. For those who want to became physicists specialized in nuclear and elementary particles interactions, the proposed themes are: nuclear models and reaction mechanisms, symmetries and conservation laws in elementary particles physics, relativist nuclear physics, quantum electrodynamics and chromo dynamics, cosmology and high energies physics, standard model, phase transitions in nuclear matter, states and processes non-conventional of nuclear matter at high energies, heavy ions reactions, hadrons spectroscopy, experimental methods, data acquisition and elements of nuclear electronics, images processing in detectors with visualization and neuronal networks, dosimetry, radioprotection and radioecology; for this section are organized postgraduate master studies of 1,5 years.

On the other hand, the Physics Faculty of Bucharest organizes postgraduate courses on “Radioactive isotopes utilization”, for graduates of superior education system, in various activity types of the nuclear field (medicine, biology, nondestructive control, metrology, applied and fundamental scientific research, etc.). The courses consist in general education on atomic and nuclear physics basis and nuclear legislation and specific training for the activity type envisaged. All these courses have to be approved by the CNCAN. The graduates can apply and obtain, after an examination, a practice permit issued by the CNCAN.

For those interested in nuclear power engineering field, there are several Power Engineering Faculties within Polytechnic Universities of Romania. Founded in 1950, the Power Engineering Faculty of Polytechnic University of Bucharest is the only one offering a specialization in Nuclear Power Plants (organized in 1965). The activity of the teaching staff in the faculty is marked by active research syllabus, based on scientific co-operation contracts with specialized industry units. This activity is correlated with postgraduate training curricula and facilitated by the existence of faculty laboratories and research centers with a high degree of financial and scientific independence. To ensure the necessary qualities of the future power specialist, new curricula have been introduced in 1990, their content being correlated with the new objective set forth; in this activity, the updating of the traditional scientific cooperation with great universities in the world, especially with the ones in the Western Europe resulted in new technologies, technical and scientific research and computing hardware obtained and implemented. Students of NPP specialization of power engineering profile of the faculty are provided with courses on nuclear processes, nuclear materials, nuclear reactors theory and engineering, nuclear safety, NPP modelling and simulation, nuclear installations technology and engineering, dosimetry and protection against
radiations, NPP control and management, severe accidents management, etc; also, for postgraduate studies they have the possibility to choose a specialization on radioprotection and nuclear safety.

3. Nuclear Research in Romania

The nuclear research organizations and institutes are the primary sources of scientific and technological information, which lead to the nuclear field development. The R&D institutes promote the technological transfer, the nuclear industrialization and standardization of design and requirements.

Founded in 1949 as a small Institute of Physics of the Romanian Academy, “Horia Hulubei” National Institute of Physics and Nuclear Engineering (IFIN-HH) of Magurele, Bucharest is a national institute for research & development, which has as main missions the basic research, applied research, technological development and postgraduate education on nuclear sciences (short term specialization in nuclear field for various specialists using radioactive sources). IFIN-HH is equipped with large-scale facilities, such as a VVR-S Nuclear Reactor (now, in conservation), an U120 Cyclotron, a MP Tandem Accelerator, a Radioisotope Production Center, a Nuclear Waste Processing and Storage Center and a Multipurpose High Dose Gamma-Ray Irradiator. The main objectives of the research program for 2003-2005 period are: modelling of fundamental processes in quantum systems by analytical, informational and experimental methods; fundamental researches on atomic and nuclear physics; developments and applications of accelerated particles steams; researches in life and environmental physics domain; enhancement of the competence, adequacy and competitiveness of services and micro-production activities; consolidation of R&D divisions with micro-production and services potential; studies on radioactive waste processing and nuclear installations decommissioning. The principal research areas of IFIN-HH are: theoretical physics, high energy and particle physics, nuclear structure and reaction mechanisms, atomic physics, interdisciplinary researches with accelerated particle beams, nuclear technologies, nuclear radiation metrology, radiation biophysics and biochemistry, radioecology, nuclear medicine, nuclear energy, instrumentation for nuclear research and technologies, vacuum technologies, information systems, data bases and computer networks. Related to international cooperation, IFIN-HH is involved in large-scale international experiments, regarding the nuclear structure and interactions at intermediate and relativistic energies (DRACULA, EUROBALL, FOPI, etc.) and particle physics (ATLAS, COMPASS,
DAFNE, etc.); also, IFIN-HH participates at EU and IAEA projects, such as RODOS, IDRANAP, VAMP, etc.

The National Autonomous Company for Nuclear Activities (RAAN) through the Nuclear Research Institute (ICN) of Pitesti and the Center of Engineering for Nuclear Objectives (CITON) of Bucharest is the main responsible organization for development of national technical support of nuclear power in Romania. The main objectives of the RAAN research, development and engineering strategic program are: to provide solutions in order to maintain a high level NPP availability factor and to decrease the operation costs, to provide support for licensing of Cernavoda NPP, to improve the NPP design by the operation experience feedback and development of a NPP life management program, to reduce the radiation exposure of operating personnel and the public, and also reducing NPP operation impact on the environment, to develop the concept and associated technologies for the safe final disposal of medium and low level radioactive wastes, to develop and maintain the research infrastructure (research reactor, irradiation devices, post-irradiation examination lab, waste treatment installations, etc.).

Founded in 1971 as an Institute for Nuclear Technologies, ICN Pitesti is now deeply involved in the execution of the following R&D programs, managed by the RAAN, in order to achieve its objectives: nuclear safety; fuel channel; nuclear fuels; fuel handling; management of radioactive wastes and of spent fuel; environment protection; steam generator; process systems and equipment; circuits chemistry; instrumentation and control; analysis of NPP operation events, ageing, environment qualification and increase of NPP lifetime; advanced nuclear reactors; extension of TRIGA reactor performances; irradiation technologies and radioisotopes; application of information technology in nuclear activities; heavy water and tritium; application of nuclear techniques. ICN Pitesti is equipped with large-scale facilities, such as a TRIGA Research Reactor, a Reliability and Testing Laboratory, a Post Irradiation Examination Laboratory, a Radioactive Waste Treatment Plant, a Fuel Performance Analysis and Fuel Safety Research Laboratory, and others. Related to international cooperation, ICN Pitesti is co-operating with some international organizations, such as IAEA (participation in two technical working groups on fuel performance and technology and on NPP control and instrumentation, contribution to IAEA co-ordinated research projects on hydrogen degradation of physical properties of Zr alloys and on data acquisition systems for water chemistry and corrosion control in NPP, several technical cooperation projects, etc.) and with NEA-OECD (participation to the NEA/IAEA International Fuel Performance Experiments Database, ICN
being the Romanian contact organization with NEA/OECD Data Bank). Also, in 1998 a Memorandum of Understanding between the Department of Natural Resources of Canada and the Ministry of Industry and Trade of Romania was signed, regarding the R&D of nuclear energy and technology, the main institutes for implementation being AECL and ICN. Further, in 1999 an arrangement for information exchange and cooperation in the area of peaceful uses of atomic energy was signed between the US Department of Energy and the Ministry of Industry and Trade of Romania, the main counterparts being DOE and ICN Pitesti.

Since 1969 till now, the Center of Technology and Engineering for Nuclear Projects (CITON), has provided the engineering support for developing the nuclear programme of Romania. The CITON engineering employees experienced in the field of design, co-ordination and management of the nuclear activities required by a nuclear programme, activities which have been certified by the years of co-operation with Canadian, European and American partners, is the only institute in Romania specialized and licensed to carry out nuclear designs. The most important achievements of CITON are: design and technical assistance activities for the objectives of IFIN-HH Magurele, including the 2.2 MWth nuclear research reactor, a linear Van der Graaf accelerator, the Center of radioisotopes production, a radioactive waste treatment plant, various research labs and a nuclear instrumentation factory; design and technical assistance activities for the objectives of ICN Pitesti, including a 14 MWth TRIGA reactor for material testing, a computer center, nuclear equipment test stands, a radioactive waste treatment plant, zero power research reactor, post irradiation labs, etc.; design and technical assistance activities in co-operation with AECL Canada, Ansaldo Impianti Italy and General Electric USA for the 5 reactors of 700 Mwe CANDU type NPP; feasibility studies and technical projects for Multi Purpose SVST-Co-60-tyoe Gamma Irradiator of IFIN-HH Magurele and many others.

4. CNCAN requirements on personnel specific training

According to Romanian Law on safe deployment of nuclear activities, the national competent authority in the nuclear field, exercising the regulation, authorization and control powers is the National Commission for Nuclear Activities Control (CNCAN), under Government subordination. CNCAN is empowered to issue regulations to detail the general requirements for nuclear safety, protection against ionizing radiations, quality assurance, controlling the non-proliferation of nuclear weapons, physical protection, transport of radioactive materials, radioactive waste and spent nuclear fuel management, intervention in
case of a nuclear accident, including the authorization and control procedures, realization of products and services destined to nuclear installations, as well as any other regulations needed for authorization and control activity in the nuclear field.

The “nuclear law” stipulates, among other conditions for obtaining a license by an applicant, to demonstrate the professional qualification, on functions, of his personnel and that the personnel knows the regulations requirements regarding the nuclear safety and the radioprotection. The applicant is also responsible for the rest of his personnel, who assures the installation functioning, having the necessary knowledge, specific of their function, regarding the installation exploitation in nuclear safety conditions, the associated risks and the applicable nuclear safety measures.

Also, in conformity with art.9 of the “nuclear law”, the authorization holder shall employ in authorized activities only personnel possessing a practice permit, valid for these activities. The practice permit is issued by the CNCAN, based on the specific regulations, also issued by the commission; the practice permit is valid for a limited period, also established by the specific norms; the issuing of the permit is done after an evaluation and examination, by the commission or the authorization holder, accordingly to the specific regulations provisions.

For example, the Radiological Safety Norms on issuing practice permits for nuclear activities and designation of accredited experts in radioprotection (NSR-07) establishes the requirements of qualification and examination and the method of issuing the practice permits for the professional exposed personnel, responsible for radiological safety and accredited experts in radiological protection; also, these norms establishes the mode of issuing practice permits for nuclear activities with insignificant radiological risk; for the NPP and research reactors operator personnel, the correspondent norms are currently in preparation. The practice permit is a document that allows the possessor to deploy authorized activities in nuclear field. There are 3 levels of practice permits: a) practice permits of level I, issued by the CNCAN or by the authorization holder, for persons involved in nuclear activities with low radiological risk; b) practice permits of level II, issued by CNCAN for personnel deploying nuclear activities with significant radiological risk and which allow the possessor to be responsible for radiological safety in the controlled area or to conduct activities with radioactive sources or nuclear installation, in the field or specialty for which the permit was issued; the practice permit of level II can be issued also by the authorization holder, if he is designated by the CNCAN as personnel certifying body; c) practice permits of level III, issued by CNCAN as recognition of accredited experts in radiological protection (specialists who
have the necessary knowledge and training for consulting in dose assessments, realization of an effective protection of persons and appropriate utilization of radioprotection means and equipments). The issuing of a practice permit must be done before starting the nuclear activity. The issuing of the practice permit is based on an evaluation and examination of the applicants, made by CNCAN, by the authorization holder or by a body designated by CNCAN to certify the personnel; in the last case, the examination mode has to be verified and approved by the CNCAN. The training programs and the complexity of examination subjects must be correlated with the level of practice permit required and the practice specificity. The examination themes are stipulated in NSR-07 and also, in other specific norms issued by CNCAN. NSR-07 establishes the conditions and requirements for issuing the practice permits, too. For example, a practice permit of level III is issued for a 5 years period, for accredited experts with established attributions, and can be renewed or extended to other domain and/or practice, after an examination. An applicant can be examined if he is an university graduate in physics, chemistry, industrial chemistry or engineering, he is a graduate of a radioprotection training course of level III, approved by CNCAN and he is certified for a practice period of minimum 15 working days, as part of the radioprotection training program of level III. In order to verify the knowledge required for the specific domain training of the applicant, he is examined by CNCAN, according to a methodology detailed described by specific provisions of the NSR-07.

Also, every CNCAN specific norm, regulating different type of nuclear activities, contain a chapter named “Personnel training”, which establishes the requirements on personnel qualification needed for that type of activity. For example, chapter V of Radiological Safety Norms on operational radioprotection in uranium and thorium mining and milling contains a paragraph named “Personnel training”, consisting in 6 articles, in which are established the minimal components of the general and specific qualification and periodic training program for professional exposed workers, the supplementary training requirements for the supervisors, the obligation of the authorization holder to keep the recordings of every training for every worker.

On the other hand, the Norms regarding the authorization of Quality Assurance management systems applicable to realization, functioning and decommissioning of nuclear installation stipulate in chapter VI, “Certifying/authorizing the personnel with functions in QA management”, the initial qualification and professional experience requirements for the QA system staff. Thus, the leader responsible for establishing, developing and maintaining the
QA system, the staff of the QA compartment and the personnel of the QA independent evaluation unit, must have all the necessary resources, authority and specific knowledge, must be graduates of a specialization course approved by CNCAN and must be certified/authorized by the CNCAN; further, all these persons have to be trained, certified/authorized and experienced in their field of activities, have to know the specific legislation, regulations and standards and the QA system applied in their organization. The certification/authorization is issued by CNCAN after the evaluation of the documents presented by the applicant and after a knowledge examination of the personnel. The certification/authorization is valid for two years, the organization being responsible for assuring the necessary resources for the continuous training of the personnel involved in QA system. Also, the Norms regarding the general requirements on QA management systems applicable to realization, functioning and decommissioning of nuclear installation, established in chapter IX, “Personnel training and qualification”, that the organization is responsible for the identification of personnel qualification and training needs, for the periodic training of the staff, for the permanent evaluation of the training programs, for the verification and maintenance of the staff competency and for keeping records about the qualification, training and experience of the personnel. All the other Norms regarding the specific requirements for the QA systems applicable to evaluation and selection of nuclear installations site, research and development in the nuclear field, nuclear installation design, commissioning, exploitation and decommissioning, etc., contain a chapter referring to personnel training, which establishes the specific requirements for the qualification and training of the personnel.

Regarding the authorization of nuclear reactors and nuclear power plants operators, managers and trainers, CNCAN elaborated a draft form of Norms on issuing practice permits for nuclear installations operators, trainers and managers. These norms will establish the legal requirements for qualification and training of the above mentioned personnel, the authorization process steps, the methodology of evaluation of the operators, trainers and managers, the methodology of approval the training programs, the methodology of issuing the practice permits.

According to the Fundamental Norms on Radiological Safety, the authorization holder has the obligation to assure the proper training and refresh training of his exposed personnel, at least once in 5 years, by a training system recognized by the CNCAN.
CNCAN has the legal responsibility to approve the training programs organized by different institutions (Physics Faculties of Bucharest, Craiova, Iasi, Training Centers for specialists in nuclear field of IFIN-HH, Cernavoda NPP, etc. and different other professional institutions). Each training program has to be approved by CNCAN, by verifying the CV and the competency on the specific domain of the lecturers, by approving the components of the program (theoretic part and practical part), the syllabus and the duration of the course, and, by verifying the working material, the lectures plan and structure. The duration and the syllabus of the courses are different and depend on the level of the course, on the domain and specialty tackled, and on the base qualification of the students; the courses duration and syllabus, required for various domains and specialties from the nuclear field are stipulated in different specific CNCAN norms. For example, the Annex 4 of CNCAN Norms on radioprotection of persons in case of medical exposures establishes the requirements of education and training in radioprotection for medical exposures, namely the education objectives for each medical profession related to nuclear field and the themes list for programs of training in radioprotection, basic course on radioprotection for medical and dental schools, modules of training on radiological safety.

On the other hand, CNCAN, by his management team, demonstrates a real preoccupation on continuously training of his personnel. This kind of activities range for professional qualification condition of hiring people, permanent training on specific working fields of the personnel, to personnel training other institutions staff. Thus, young people hired in CNCAN, physics, chemistry or engineering university graduates, are to be specialized in their specific working domain by attending appropriate training courses, as those mentioned above. Also, CNCAN staff is trained by attending training or train-the-trainers courses, or workshops, included in different IAEA or PHARE projects. Regarding the internal training of the personnel, CNCAN established an annually program of training, according to which every CNCAN member have to sustain 2 presentations per year (one in Romanian, one in English) in front of his colleagues. Finally, experienced personnel or those nominated as national trainers are involved as lecturers in different specific training programs of other national institutions.

As an example, the personnel of CNCAN Radiological Emergencies Section was trained in radiological emergencies preparedness and practical response, as part of CNCAN participation to IAEA RER 9/050 and RER/9/065-016 project and PHARE project RO/RA/02 (task 5). As a result, they are working in radiological emergencies field, they are actually
involved in the CONVEX-3(2005) Cernavoda International Nuclear Emergency Exercise preparation, they will present this years in front of their colleagues 6 themes related to nuclear and radiological emergencies preparedness and response. Also, these persons participated as lecturers to several training courses named “Radiological Emergency Practical Response”, organized by the Romanian Civil Protection Commandment in co-operation with CNCAN, and destined to Civil Protection Inspectorates personnel, but not only (the courses were attended also by local police and medical units). Further, these persons assure the CNCAN participation to Radiation Emergency National and International Exercises (general exercises organized by Cernavoda NPP, Civil Protection Commandment and CNCAN, as AXIOPOLIS 2001, international exercises organized by Civil Protection Commandment, CNCAN, NATO and IAEA, as DACIA 2003), as organizers, observers, evaluators, and even active participants.

5. Public information

Another important issue related to education in nuclear field, is the public information. According to the Law no.111/1996 with consequent completions and modifications, CNCAN has the responsibility to assure the information of the public, by official publications, press releases, press conferences, organized by his Public Relations Section, under the direct supervision of the CNCAN President.

On the other hand, according to the national legislation, the authorization holder has to establish and maintain a public information system. For example, the Public Relations Section of Cernavoda NPP deploys an annual program named “Communication, public relations and image CNE PROD”. This program contains two parts, one related to internal communications and the other, related to external communication. The internal communication is realized via e-mail or Internet and by monthly editing of informal bulletins (placed on communication boxes on site). At the end of august, this year, the web page of Cernavoda NPP will be ready. The external communication is realized by many means, such as: “InfoNuclear” bulletins, placed on several bulletins centers (placed in city halls, for example), visits to important local objectives (as schools, high schools, kindergartens, etc.), press releases and conferences organized in case of planned or unplanned events, editing and reviewing of information brochures, public opinion test program, “Open Doors” program, training of other institutions personnel involved in radiation emergency response, etc.
6. Conclusion

Romania is deeply involved in a constant development of the nuclear power engineering. Romania is currently the only country in Europe building a new reactor unit at Cernavoda Nuclear Power Plant. That’s why the nuclear safety education is administrated at various levels in the primary school, high school and university education and strongly implemented at operational level in the major nuclear installations of the country. This is the reason way the legal requirements regarding the initial qualification, the proper training and the constant refresh training of the personnel involved in all kinds of nuclear activities represent an important element of the regulatory activities of the CNCAN, as the national competent authority in the nuclear field.

CNCAN regulations
DACIA 2003 Radiological Emergency International Exercise
(“dirty bomb” explosion)
Civil Protection personnel Training Courses on “Radiological Emergency Practical Response”