EXPERIENCE AND CO-OPERATION IN THE DEVELOPMENT OF NUCLEAR ENGINEERING EDUCATION

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ABSTRACT

This paper presents various aspects of the international co-operation set up at the Institut National des Sciences et Techniques Nucléaires (INSTN) for developing the nuclear engineering education in a European framework, with the Tempus programmes, or world-wide, through the IAEA technical co-operation programme. As such co-operation mainly relies on the courses established in the INSTN for national purposes, a short presentation of them is made first.

Nuclear engineering education in France is completed through a comprehensive postgraduate program called the "Génie Atomique". This program is quite specific inasmuch as it is not a university one if compared to, for instance, the American system. Obviously, the French Universities, in collaboration with the INSTN, propose numerous postgraduate degrees providing students with a high specialisation in one of the various disciplines related to nuclear engineering, such as reactor physics, nuclear materials, radiochemistry. Nevertheless, only the "Génie Atomique" program covers all of the fields related to nuclear engineering.

The "Génie Atomique" education is taught within the "Institut National des Sciences et Techniques Nucléaires" (National Institute for Nuclear Science and Technology, INSTN). Being an integral part of the "Commissariat à l'Energie Atomique" (Atomic Energy Commission, CEA), the INSTN is a postgraduate education institution created in 1956 and placed under the joint control of the Ministry of Industry and the Ministry of Research and Higher Education.

Since the early 1950s in France, as in many other countries, the need became apparent to train engineers to have an overall view of the sciences and technologies involved in building and operating nuclear plants, and in fuel cycle processes. The training in "Nuclear Engineering" meets this need.

Students pursue their curriculum at Saclay (near Paris), Grenoble or Cadarache (near Aix-en-Provence), which are three sites of the INSTN nuclear engineering school. The "Génie Atomique" program lasts one academic year (9 months full-time running from October to late June) and is split up into three 3-month periods.

The first term consists of a core curriculum during which students become acquainted with a set of basic disciplines, often totally new to them, such as those following:

- neutronics
- reactor physics: kinetics, reactor control
- thermal physics and diphasic thermal hydraulics
- nuclear and structural materials
- nuclear instrumentation
- physico-chemistry of the fuel cycle
- radiation protection
- safety.

During the second term, students can choose a major from a range of options to study more thoroughly one of the nuclear engineering aspects :

- nuclear reactors modelling
- operation and operating safety
- fuel cycle
- reactors control-monitoring and instrumentation
- thermohydraulics and safety.

During these two first terms, the emphasis is placed on practical work that students carry out specifically on CEA experimental reactors and on educational tools as simulators testing reactor behaviours under normal or emergency conditions. One of the characteristics of the "Génie Atomique" program is the fact that professors and lecturers are mostly professionals from industry or the nuclear research field, high-level engineers or researchers, sharing their up-to-date knowledge and experience with the students.

The last term is devoted to a study project. In groups of two or three, students undertake this project during an internship carried out in one of the main nuclear branch companies : CEA or CEA subsidiaries (Framatome, Technicatome, COGEMA), Electricité de France (French Public Utilities), or even abroad (Obninsk Institute for Atomic Energy in Russia, Staatliche Materialprüfungsanstalt in Stuttgart, Germany). The project involves the detailed study of a nuclear plant, which allows students to tackle all the nuclear engineering aspects and master their complex interactions. The overall survey of nuclear systems helps students to understand the necessary choices inherent to any implementation of such importance.

After completing the course, students may be awarded the "Génie Atomique" degree. Every year, 80 future nuclear engineers attend that program. Around 3500 students have been graduated since the creation of the "Génie Atomique" in 1955.

It must be emphasised that all the "Génie Atomique" graduates have joined multi-disciplinary teams throughout the nuclear industry, as top-level professionals in charge of nuclear systems design, nuclear plant operation, safety analyses, and radiation protection.

Coming now to the various aspects of international co-operation in the development of nuclear engineering education, the first point to be mentioned is that, in accordance with the general features of the French education system, foreign students are accepted in the INSTN courses under the same conditions as French students, without paying any tuition fees, provided that they comply with the academic prerequisites.

Accordingly, it is easy for individuals who want to specialise in nuclear engineering to apply to take one of the courses organised at the INSTN. Obviously the same applies to students coming within the framework of agreements with foreign institutions but, in those cases, additional features can build up an exciting accumulation of fruitful exchanges through co-operation between the INSTN and the Obninsk Institute for Nuclear Power Engineering (OINPE).

ACCUMULATED EXPERIENCE OF CO-OPERATION BETWEEN THE INSTN AND THE OINPE

Following the Chernobyl accident, and thanks to perestroika, the INSTN was encouraged by the French Atomic Energy Commission (CEA) to cooperate with Russia in order to help their nuclear scientists (whose economic situations were continuously deteriorating) not to leave their occupation when improvement in the safety of all the Russian nuclear installations was a top priority.

The co-operation established since 1989 between the INSTN and the OINPE involves the students, the professors and the institutions.

About ten French Génie Atomique students went to Obninsk for three-month periods of time for their work projects; where they found very satisfactory scientific support.

The OINPE students, fifteen of them who were finishing their fifth, i.e. last year of Nuclear Engineering courses, have participated in an exchange programme, spending 3 to 6 months on work projects in a CEA laboratory, one year in the Génie Atomique, or four years in preparation for a doctorate degree.

Regarding the professors, two or three of them come each year from Obninsk to lecture the Génie Atomique students. A book on "Experimental reactor physics", in the French language, has been published by the Russian publisher MIR, as part of the co-operative financing of this programme..

Finally, INSTN and OINPE cooperate in various other ways, for example in the organisation every two years of an international conference in Obninsk on Nuclear Safety and Education.

TEMPUS, A EUROPEAN UNION PROGRAMME TO HELP RESTRUCTURE EASTERN COUNTRIES' UNIVERSITIES

A few years ago, the European Union launched a series of programmes to help central European countries to solve the numerous problems encountered after the significant political changes. Among these programmes, are the so-called Tempus programmes, aimed to help Eastern European universities update their curricula and improve their organisation. The INSTN is the contractor for a Tempus programme in favour of the Romanian university Politechnica in Bucharest. Two other European institutions, the Centre d'Etudes de l'Energie Nucléaire (SCK-CEN) in Mol, Belgium, and the Instituto de investigacion Tecnologica (IIT) in Madrid, Spain participate in this three-year programme which sets up a new master on Nuclear Safety and Radio-protection. Due to significant financing by the European Union(550 000 US$ for the 3-year programme) about 20 Romanian professors are able to visit their counterparts in Western European institutions each year to share their experiences, for a total duration of 70 weeks.,. One third of the total budget is devoted to modernising equipment in the laboratories.

IAEA INTER-REGIONAL TRAINING COURSES AT THE INSTN

Finally, the infrastructure set up by the INSTN to organise the Génie Atomique course has been used to house an inter-regional training course, approximately twice a year, within the framework of the technical co-operation programme launched by the IAEA 20 years ago in favour of developing countries.