Transactions of the American Nuclear Society v. 42, n. 2, p. 136-137
1982

NUCLEAR EDUCATION AND TRAINING — I

1. Education and Training in Brazil for the Nuclear Technology Transfer Program, *Rui Ribeiro Franco (IPEN — Brazil)*

This brief paper consists of two parts: what the Brazilian Nuclear Energy Commission (CNEN) and the Nuclear Manpower Formation Program (PRONUCLEAR) have been doing in the field of education and training for the nuclear technology transfer program; and what the State of São Paulo Institute for Nuclear and Alternative Energy Sources Researches has been doing in the same areas.

The countries in the process of introducing nuclear power face challenging nuclear technology transfer and education problems. Reinforcing and upgrading of non-nuclear education areas, such as mechanical and electrical engineering, material technology and testing, welding technology, quality assurance and standardization, seem to be at least of the same importance for a nuclear program as establishment of nuclear disciplines; e.g., reactor physics, safety, radiation protection, etc. In Brazil, nuclear scientists and professionals are being trained primarily on the postgraduate level at selected universities closely cooperating with the group responsible for manpower development for the nuclear sector, the PRONUCLEAR (Nuclear Manpower Formation Program), an interministerial group devoted to the subject.

This development of university education certainly implies the need for higher qualified local professors for the above areas, and the eventual assistance of visiting foreign experts.

In addition to this basic training, which the country can provide through existing facilities, it is mostly desirable to have other kinds of specialized training through external cooperation offered by bilateral agreements or by the assistance of international organizations.

On-the-job training, which is generally regarded as a complement to academic training to provide experience for junior technicians, if conducted at more advanced foreign centers, may also be used as an efficient measure to improve or update the knowledge of already experienced staff members of Brazilian institutions, thus conciliating to the possible extent their career aspirations with the needs of the organizations to which they belong.

CNEN and PRONUCLEAR are fortunate to receive the efficient support of KFA — Der Kernforschungsanlage Jülich GmbH, and KFK — Der Kernforshungszentrum Karlsruhe either in nominating experts to give advice and conduct courses in Brazil, or in providing on-the-job training at several institutions of the Federal Republic of Germany for a large number of Brazilian scientists and engineers.

Although the educational aspect of this personnel exchange program is predominant, both sides consider it as a necessary preparatory step to carry out joint research projects on a partnership basis.

Education and training for the nuclear technology transfer program at the State of São Paulo Institute for Nuclear and Alternative Energy Sources Researches (Instituto de Pesquisas Energéticas e Nucleares — IPEN) in São Paulo, offer a unique combination of academic training opportunity combined with research facilities of a similar nature. Students thus have an opportunity to participate in large reactor engineering projects.

Since its foundation in 1956, Instituto de Pesquisas Energéticas e Nucleares has been active in training young graduates in the area of nuclear sciences. In 1968, formal graduate training leading to an MSc Degree in nuclear science and technology was established through agreement with the Escola Politécnica (School of Engineering) of the University of São Paulo. In 1976 and 1977, respectively, IPEN approved two new areas of graduate studies: Nuclear Technology (CTN) and Nuclear Power Reactor and Nuclear Fuel Technology (RNC) to graduate people from Brazilian and South American universities. Graduate nuclear engineering students are on the scientific staff of IPEN. Most of these students are full time employees of the Instituto, dedicted partly or entirely to academic training; students initially enter the Instituto with full scholarships, and after a satisfactory probation period are offered permanent positions.

The following special local conditions make nuclear engineering education at IPEN substantially different from that at foreign universities:

1. In the absence of industrial opportunities for nuclear engineers, IPEN created special incentives to encourage graduates to stay in this field. One such incentive includes the opportunity to pursue full time graduate training while being employees of the Instituto.

2. The shortage of qualified nationals makes training programs substantially dependent on foreign specialists.

3. Students have opportunities to work on real life problems of considerable challenge and immediate relevance to the emerging Brazilian nuclear energy program. Although this latter task is independent of the academic training programs, in this case, specific academic needs are combined with the project requirements by offering parts of the projects as research topics for a Master's Thesis.

The main projects currently being followed at the Instituto are: redesign and upgrading of IPEN swimming pool research reactor from 2 to 10 MW(e); fuel element technology and nuclear metallurgy; uranium and thorium purification; uranium tetrafluoride and hexafluoride production; radiation chemistry;

radioisotope applications in industry; installation and fluid mechanics studies with an 800°C helium thermal loop; stress analysis and reduced model technology of a prestressed concrete vessel; reactor materials studies; and health physics. A number of computer codes from abroad are presently being adapted to the IBM 370/155 containing 1 million bytes of memory, for reactor calculations.

Because of the success in the Master's Degree (MS) postgraduate courses in nuclear engineering and technology, the Instituto de Pesquisas Energéticas e Nucleares extended these postgraduate courses to the level of Doctor of Philosophy (PhD).

In addition to these postgraduate courses in nuclear engineering and technology, an agreement with the Institute of Chemistry, University of São Paulo, has enabled several IPEN chemical engineers and chemists to successfully defend both MS and PhD theses in nuclear chemistry. Both MS and PhD theses may also be presented by IPEN research workers to the Institute of Physics, University of São Paulo, with which an agreement has been in operation for several years.

IPEN and PRONUCLEAR have also been working together in educating and training students coming from high schools (age 18 to 20) to help nuclear engineers, physicists, and chemists. These trainees have proved to be of very great importance to Brazilian nuclear institutions.

Training courses of a less scientific nature are offered to technicians. They provide knowledge concerning a number of special nuclear techniques (reactor control, decontamination, radiation protection, and ionizing radiation monitoring).

By considering the special conditions prevailing in developing countries with a yet incipient nuclear industry, the IPEN experience in training scientific personnel might be considered highly successful.

2. The Need for Efficient Basic Training, *J. Pellerin, R. Pons, M. Rapin (CEA — France)*

While some highly industrialized countries have progressively developed their nuclear programs since the very beginning of nuclear energy development and accordingly experienced all the intermediate steps of its industrial development, several countries have started significant nuclear programs much more recently and yet others are still considering the possible use of nuclear energy.

In the first case, the necessary nuclear specialists have been gradually trained according to the needs and have gained their experience while encountering the problems as they arose at the successive steps of nuclear energy development. In the second case, specialists must be trained in a relatively short time to cope with the problems directly related to the industrial use of nuclear energy.

For a country starting a nuclear program, the following questions arise:

1. What kinds of nuclear specialists are needed?
2. What training is necessary?
3. How and where can such training be obtained?

When looking at the kinds of specialists that will be needed to develop efficient nuclear energy on a national basis, several specific aspects of the nuclear field must be kept in mind:

1. The range of specialties involved in carrying out a nuclear program is quite wide and includes, besides obvious activities directly related to nuclear plant design, construction, and operation, several other activities that must not be neglected: energetic planning, nuclear fuel transportation, nuclear material handling and storage, protection against radiation, public information, specialized teacher training, etc.

2. The nuclear industry is characterized by more stringent requirements than those used by classical industry; e.g., accuracy of measurements, safety and environmental specifications, radiation dose limits, factory tolerances, and quality of the materials used for component fabrication.

3. As in any other industry, the engineers and scientists in charge of analyzing problems or designing devices must have theoretical knowledge, as well as the practical knowledge to execute the tasks. Special effort will have to be made to train efficient technicans and workers who are aware of the specific characteristics of nuclear energy.

Efficient training of nuclear specialists includes three steps to be clearly differentiated:

1. general technical training suited to each level of responsibility, provided by colleges, universities, institutes of technology, and technical schools
2. basic nuclear training, which is given by specialized organizations
3. specialized training corresponding more particularly to specific work and given by the industry in charge of that work; e.g., component fabrication, reactor operation, safety analysis, and health physics.

These three steps concern every level of nuclear specialist to be trained: engineer, technician, and worker.

If the last step is generally well discerned due to anticipated precise needs related to nuclear development, the importance of the first two steps is often less weighted. One must realize that specific nuclear techniques, which are rather intricate, can be efficiently tackled only after a sound general technical education has been received. Indeed, specialized training, which in most cases is a proficiency transfer from experienced countries to countries starting their nuclear effort, must be efficient so the future nuclear specialists are well prepared to assimilate the nuclear techniques. Last, but not least, achievement of the first two steps contributes to creation of a favorable scientific environment, which helps prepare future specialists and promotes possible technology transfer.

As a consequence, it appears that training nuclear specialists is a difficult operation which requires:

1. a precise definition of needs, starting from the general technical level down to the most specific nuclear problems to be handled