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Human Resource Development Strategies Adopted by the Department of Atomic Energy, India

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Introduction

Nuclear science and technology is a multidisciplinary subject and has come to the present stage of development as a result of advances made during the past 100 years. It is a highly specialized subject and has a very high knowledge content. To deploy nuclear technology, one has to evolve organization structure to pursue research and technology development in a synergistic manner. Development of human resource needed for harnessing of nuclear technology needs special attention. When we started atomic energy programme in India we had some additional constraints because hi-tech industry was still in its infancy. Therefore, several jobs, which in industrialized countries could be done by industry, had to be done by the nuclear establishment in India. We, thus, had to set up organizations, which could do what advanced countries were doing and also do more to compensate for the lack of necessary industrial infrastructure. This also called for training human resources for manning all the organizations.

Nuclear science in India started with the setting up of Tata Institute of Fundamental Research in Mumbai in December 1945 and atomic energy establishment grew out of it. Bhabha Atomic Research Centre (BARC), the first nuclear research centre in India, located in Mumbai, has evolved around the research reactors Apsara[1] and Cirus[2] and over the years more research reactors, experimental facilities for basic and applied research and even industrial scale plants have been added. This research center is the mother

[1] It is a swimming pool type research reactor and attained first criticality in 1956.
[2] It is a 40 MWt research reactor and attained first criticality in 1960.

institution of all the other nuclear research centres as well as the atomic energy programme in India.

In view of the knowledge intensive nature of the nuclear technology and the state of hi-tech industrial infrastructure in India, Bhabha Atomic Research Centre (BARC) has been designed to have a composite character. It is a large institution and has been pursuing activities starting from basic research to technology development. At BARC, we have also put in place a very effective human resource development programme and this programme is run by faculty drawn from within the organization. As a result, BARC has attributes of an institute, a research laboratory and also an industrial organization.

The composite character is confined not only to BARC but also extends to the Department of Atomic Energy (DAE) as a whole. Simultaneous with research centres, we have been setting up industrial units. The fountainhead of success of the atomic energy programme in India is the fact that both the research centres, which generate knowledge and the industrial units, which generate wealth from the knowledge, are under one umbrella and that is the DAE working under the policy framework laid by the Atomic Energy Commission. The two sets of institutions maintain an organic linkage permitting seamless interaction and facilitating technology transfer without any cumbersome formalities. The common policy framework followed by all the institutions enables the department to follow an integrated approach towards human resource development and this further strengthens the linkages between the institutions. This has enabled the country to be self-reliant in all aspects of nuclear fuel cycle, starting with prospecting and mining of uranium and ending with the back-end of the fuel cycle, which involves reprocessing of the spent fuel and nuclear waste management. Most of the R&D work, which led to realization of this capability, was done or initiated at BARC at Trombay. Some of the activities have now been taken over by other research centers: IGCAR at Kalpakkam for fast reactors, Centre for Advanced Technology (CAT) at Indore for accelerators and

lasers and Variable Energy Cyclotron Centre (VECC) at Calcutta for accelerators. The Atomic Minerals Directorate for Exploration and Research (AMD) is engaged in prospecting of uranium.

The nuclear power reactors are built and operated by the Nuclear Power Corporation of India Ltd. (NPCIL). The Uranium Corporation of India Ltd. (UCIL) mines uranium. Support in the area of electronics and instrumentation comes from Electronics Corporation of India Limited (ECIL). In addition, we have several industrial units working within the government framework. These are the Heavy Water Board (HWB) for production of the heavy water and the Nuclear Fuel Complex (NFC) for the production of fuel and structural materials. Fig 1 gives organizational chart of the Department.

BARC Training School

In the beginning of the atomic energy programme, it was necessary to set up a mechanism to provide training in nuclear science and engineering. It was based on the realization that programmes of higher education, because of their focus on specialization, have to be followed by assured placement. There has to be a direct link between the 'user' and the 'programme' – both in terms of course content and the number of students. Therefore, for recruitment to the DAE, a methodology based on the principle of 'hire and train' was devised and is still being followed. Young graduates are hired and given an orientation course in nuclear science and engineering at BARC Training School. It is a very cost-effective programme and ensures that those trained are hired and the course content meets the requirements of the department. This programme has been running since 1957. As indicated earlier, the faculty for the training school is drawn from amongst the scientists and engineers working in the institutions of DAE. Practicing scientists and engineers, working as adjunct faculty, provide excellent exposure of the subject to the young students. An engineer, working on the design of equipment for a nuclear power plant, is best qualified to teach engineering design to the students. Similarly, a physicist engaged in reactor

physics calculations as a part of his daily routine develops an insight into the subject and can convey this insight to the student. Over 6000 students have graduated from this Training School and currently it runs the programmes in the following disciplines.

- Chemical, computer, electrical, electronics, metallurgy and mechanical engineering.
- Physics, chemistry and biology.
- Radiation protection and environment sciences.

The course includes 450 lecture hours including laboratory work. The course content includes subjects such as Nuclear Physics, Reactor Physics, Health Physics intended to provide an orientation towards nuclear sciences and special subjects consistent with basic qualification of the student. The students also visit facilities in BARC and sister units including nuclear power plants. Project work for 6 weeks duration is in addition to lectures. Assessment of students is based on written tests, viva-voce, home assignments and evaluation of project work. Syllabus is continuously updated to include latest advances in the subject and to take care of the requirements of the department. Intake to this school in the recent past has been about 120 every year.

Besides one-year orientation course, we run another scheme in the Training School. From 1992 onwards, we have been recruiting engineers with post-graduate qualification in engineering and give them a short orientation course of one semester. This is a condensed version of the one-year course and is run in a similar pattern. Intake is about 20 every year.

From the year 2002, we have started DAE Graduate Fellowship Scheme (DGFS). Students, who have been selected for admission to post-graduate degree programme in engineering at select institutes[3], can apply for this scheme in the beginning of the programme and if selected, they are 'adopted' by the

[3] To implement this scheme, agreements have been signed with the Indian Institutes of Technology (IIT) at Chennai, Delhi, Kanpur, Kharagpur, Mumbai and Roorkee.

department. This includes payment of monthly stipend, book allowance, reimbursement of tuition fee paid by them and certain other benefits. In return, they take up electives and project work in an area of interest to DAE. In the first batch itself, 36 students have joined this programme and it means that 36 projects of one-year duration will be done at the select institutes under the joint guidance of Institute faculty and DAE scientists. This scheme has twin objectives viz., human resource development and involving the faculty at the select institutes in the programmes of the DAE.

To cater to the requirement of manpower for expanding nuclear power programme, we have opened additional schools as affiliates of BARC Training School. One such school is at the Centre for Advanced Technology, Indore, which concentrates on training students in the area of lasers and accelerators. Two batches (~30 students) have already graduated from this school.

Another school is at Nuclear Fuel Complex, Hyderabad, which concentrates on training manpower for manning heavy water plants, fuel fabrication plants and fuel reprocessing plants and waste management facilities. One batch (~20 students) has already graduated from this school.

NPCIL needs a large number of engineers for operation and maintenance of nuclear power plants and it runs its own training centres at some of its power plant sites. About 1000 students have graduated from the centers comprising NPCIL training school.

Thus, we have several schools and schemes in place to meet the demand of the atomic energy programme. To ensure uniform quality of all the programmes, an apex committee having representation of all schools is in place for policy formulation and induction to all schools (including DGFS) is through a common procedure consisting of screening based on a written test followed by a selection interview at Mumbai. For science disciplines, we conduct our own written test on

all India basis. For engineering disciplines, Graduate Aptitude Test in Engineering (GATE) conducted on all India basis by Ministry of Human Resource Development is used for screening of candidates.

Other Training Programmes at BARC

Besides Training School, BARC also runs other training programmes, but these are not followed by assured placement. These are the following.

- Diploma in Radiological Physics (DipRP). This programme aims to equip candidates to work as Medical Physicists or Radiological Safety Officers in hospitals or industries using radiation sources. Admission is given to those having post-graduate degree in physics. Annual intake is 25.
- Diploma in Radiation Medicine (DRM). This programme aims to equip medical doctors in the use of nuclear medicine. Minimum qualification for admission is MBBS followed by one house post in medicine. Annual intake is 10.
- Diploma in Medical Radioisotope Techniques (DMRIT). This programme equips the candidates to work as technologists in nuclear medicine departments of hospitals. Minimum qualification for admission is graduation in science (Physics, Chemistry, Life Sciences, Biophysics). Annual intake is 10.

Considering that demand for manpower having the qualification DipRP is more than what is being trained by BARC, one institution at Chennai has been authorized to run M.Sc. in Radiation Physics and help is given to this institution for successfully running the course. Request from one institution at Jodhpur for help in running a similar course is being processed.

BARC also runs a one year programme to equip science graduates to work as health physics professionals in nuclear power plants and fuel cycle facilities.

At BARC, we also run several short term courses such as Radioimmunoassay and its clinical applications, industrial radiography, isotope hydrology. BARC

also offers training in various fields to the trainees sponsored by IAEA under its fellowship programmes.

To ensure that subjects like nuclear physics and nuclear chemistry are given due importance in the universities, special efforts are made to organize workshops for faculty from the universities and colleges. One special programme is run by Indian Association of Allied Chemists and Allied Scientists (IANCAS) and this involves organizing 3 to 4 workshops every year at different locations on nuclear chemistry for faculty. Laboratory equipment used for such programmes is left at the venue of the workshop for later use by the students.

Doctoral Programmes at R&D Centres and Autonomous Institutions

Several universities in India have mechanisms in place to permit student to pursue off-campus programmes leading to research degrees. Two different models are followed in India. One model is followed by institutes such as Indian Institute of Science, Bangalore, where an external registration programme has been in place since early seventies. This programme permits student to pursue research work leading to Ph.D. at their pace of work after the students have completed minimum residence requirement and cleared a General Comprehensive Examination. The second model is practiced by some of the universities empowered to affiliate institutions for pursuing research. The research centres of DAE are recognized as centres for research leading to post graduate degrees by the universities located nearby. Many senior scientists and engineers are recognized as Ph.D. advisors (post-graduate teachers) by the respective universities. The employees are encouraged to register and obtain research degrees based on the work done in the research centres. In addition, we have an arrangement with Mumbai University for the last three decades, under which we along with the faculty from the university select 12 research scholars for pursuing research leading to Ph.D. in basic sciences. Fellowship to the research scholars is paid by DAE. On similar lines, BARC and Pune University have signed an agreement in December 2000 to select 12 research

scholars for pursuing Ph.D. in basic sciences. Under this scheme two batches have already been selected. These students are pursuing Ph.D. programme under the guidance from two advisors, one from Pune University and the other from BARC.

The DAE has seven fully aided institutes pursuing basic research. Apart from TMC, all run programmes leading to Ph.D. in nuclear sciences and mathematics. The graduate school at TIFR is rated as one of the best in the world and attracts the best talent in the country. TMC has two wings viz., a hospital and Advanced Centre for Therapy, Research and Education in Cancer (ACTREC). ACTREC has been just set up and ambitious programme to take up research.

During the last three years, R&D centers and aided institutions together have produced about 100 doctorates every year.

Board of Research in Nuclear Sciences (BRNS)

Recognising that nuclear science and technology is a multi-disciplinary subject and several R&D jobs can be done by universities and laboratories outside the department, an agency named BRNS, for extra mural funding was set up by DAE right at the beginning of the atomic energy programme. The department provides financial support to outside agencies for R&D on problems of interest through BRNS. The research staff working on the projects funded by BRNS is encouraged to register for advanced degrees with the institutes/ universities where the research is done and this also leads to human resource development.

Concluding Remarks

Human resource development has been accorded a very high priority in the Department of Atomic Energy in India. It is a complex task and demands simultaneous action at several fronts. Just one isolated programme is not likely to be sufficient. Considering that a variety of competing career options are available to the young graduates, a number of parallel mechanisms with the

ultimate objective of inducting and training human resource of excellent quality have been set up. The vibrant university education system in place in the country ensures that candidates of high quality are available for hiring. The principle of hire and train ensures that there is no gap in the demand and supply of manpower.

The training at the entry level covers the following categories.

- Engineers for the design of nuclear power plants and related fuel cycle facilities.
- Engineers for operation and maintenance of nuclear power plants and related fuel cycle facilities.
- Scientists and engineers for pursuing R&D in nuclear science and technology.
- Radiation safety and health physics professionals.
- Professionals needed for nuclear medicine centres.

Sufficient incentives are provided to ensure that employees keep on updating their knowledge base while in service. One such incentive is to provide them facilities and mechanisms to get a doctorate degree while in service under off-campus programmes of universities.

We have long experience in successfully managing human resource development programmes in nuclear science and technology. In the past we have trained nationals of one country in the Training School at BARC and can do so on a large enough scale under the aegis of Asian Network of Higher Education in Nuclear Technology.

Figure 1: Organisation Chart.