# Nuclear Power Training Courses

The training of technical manpower for nuclear power projects in developing countries is now a significant part of the IAEA's Technical Assistance Programme. A nuclear power project is a complex undertaking, requiring large numbers of trained and experienced personnel at each stage of the project. There is sometimes a tendency to underestimate the magnitude of the project and the number and qualifications of technical personnel required to plan, launch, and successfully bring into operation a nuclear power station. Because practical training in these matters is not usually readily available in developing countries, the IAEA has undertaken a programme of special training courses in co-operation with host countries which have extensive nuclear experience and are capable of providing appropriate training facilities.

Two basic courses are the cornerstones of the Agency's training programme for nuclear power: a course in **planning and implementation**, and a course in **construction and operation management**. These two courses are independent of each other. They are designed to train personnel for two distinct phases of project implementation; normally a course participant would not take both courses.

The various participating developing countries are, of course, in different stages of nuclear power development, and Table 1 defines the various stages. The training course in planning and implementation is concerned primarily with the Stages 0 through 3, and the construction and operation management course is primarily useful for those countries in Stages 4 and 5. Table 2 shows the estimated stage of the various developing Member States of the Agency. Even participants from countries in Stages 0 and 1 find the course in planning and implementation useful, as it makes them aware of the magnitude of a nuclear power project.

In past years, the IAEA organized several courses and seminars related to nuclear power development, including Technical and Economic Aspects of Nuclear Power (Vienna 1969, Thailand 1973, Philippines 1976), Bid Evaluation and Implementation of Nuclear Power Plants (Japan 1971), and Nuclear Power Planning (Jamaica 1975).

In 1974, with the added stimulus of the energy crisis, these training efforts were examined to determine whether the Agency should take a more active role in nuclear power training. After consultation with a committee of experts, it became apparent that first priority should be given to training in planning for nuclear power projects. Since there were no suitable training courses being offered anywhere, the Agency undertook to prepare and conduct courses in this field.

The complexity and magnitude of the work involved in building a nuclear power station is shown in this photograph of the LaSalle site in Seneca, Illinois (USA) where two 1078 MWe boiling water reactors are being built by Commonwealth Edison Company.

**Table 1**
**Stages of Nuclear Power Development**

| | Definitions |
|---|---|
| **Stage 0:** | **Pre-planning**<br>Nuclear power planning not yet initiated. Only medium or long term potential interest. |
| **Stage 1:** | **Planning**<br>Intending to go nuclear, but without any definite plan or programme developed. |
| **Stage 2:** | **Feasibility**<br>Nuclear programme available with definite plans for a first nuclear power plant. Bidding process not yet initiated. |
| **Stage 3:** | **Contracting**<br>Decision adopted to install a first nuclear power plant. Construction not yet started. |
| **Stage 4:** | **Construction**<br>First plant under construction, commercial operation not yet started. |
| **Stage 5:** | **Operation**<br>First nuclear plant in commercial routine operation. |
| **Stage 6:** | **Confirmed**<br>At least two nuclear plants in operation; more under construction and planned. |
| **Stage 7:** | **Self-sufficiency**<br>Design, engineering, and construction capacity available within the country. |

A syllabus was prepared, and offers were received from the Federal Republic of Germany, France and the United States of America to host courses and provide facilities and instructors for them. The first course in nuclear project planning and implementation started in September 1975 at the Karlsruhe Nuclear Research Centre, Federal Republic of Germany. The course in construction and operation management was held for the first time from September to December 1976 at the Argonne Center for Educational Affairs, USA. By the end of 1976, 175 participants from 34 developing countries had completed one or the other of these courses.

**Table 2**

**Developing Countries Participating in the Nuclear Power Training Programme**

| Stage 0: Pre-planning | Stage 1: Planning | Stage 2: Feasibility | Stage 3: Contracting |
|---|---|---|---|
| Burma | Algeria | Chile | Bangladesh |
| Ecuador | Jamaica | Indonesia | Cuba |
| Ghana | Peru | Malaysia | Egypt |
| Iraq | Singapore | Thailand | Greece |
| Saudi Arabia | Venezuela | | Israel |
| Sri Lanka | | | Poland |
| Syria | | | Romania |
| | | | Turkey |

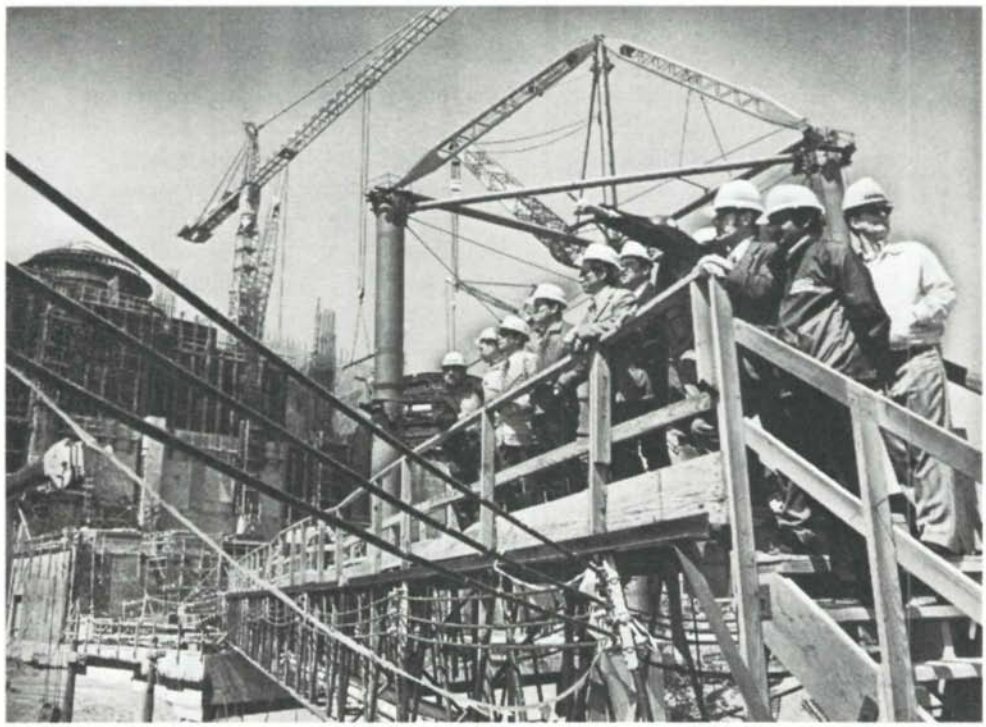
| Stage 4: Construction | Stage 5: Operation | Stage 6: Confirmed | Stage 7: Self-sufficiency |
|---|---|---|---|
| Brazil | Argentina | Bulgaria | India |
| Hungary | Czechoslovakia | Spain | |
| Iran | Pakistan | | |
| Korea, Rep. of | | | |
| Mexico | | | |
| Philippines | | | |
| Yugoslavia | | | |

## CHARACTERISTICS OF THE NUCLEAR POWER PROJECT COURSES

These courses are dynamic, adjusting to the needs of the participants and the changing experience of the lecturers. Some of the programme characteristics are:

**Participants.** The course is directed to technical managers, planners, decision makers, key engineers, and other experienced professionals who are involved in their country's nuclear power programme. Many were nominated by electric utilities. The participants who have attended so far have been well qualified. Except for a very few economists, lawyers, administrators, and scientists, they have all been engineers. Their average age has been about 36 years.

**Type of Training.** The purpose of the course is the "transfer of experience" in project planning and management, and this leads to a practical, non-academic style of training. During each course, from 100 to 150 experts give lectures on topics in which they have special competence and experience. They also participate in discussions and work sessions. One of the main benefits to the participants is the opportunity to discuss their particular problems with experts and have access to many (at times conflicting) opinions. Lecture notes and background papers are provided to the participants by each lecturer.



Participants in an IAEA-sponsored nuclear power training course are shown during a visit to the LaSalle construction site. The course is given at the Argonne Center for Educational Affairs.

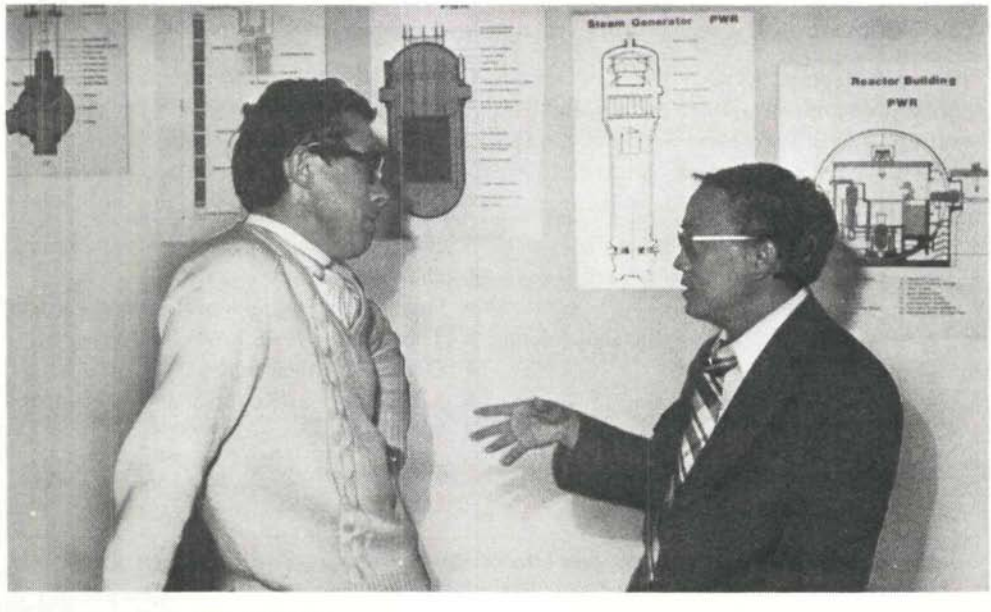
**Course Content.** The courses are designed to offer a broad overview of a nuclear power project from planning to operation, placing special emphasis on certain stages according to the main course subject area (i.e. planning and implementation or construction and operations management). Priority is given to the coverage of the main tasks that must be performed rather than an in-depth study of a particular aspect. Approximately two thirds of each course is dedicated to the main subject area, the rest consists of a general review of nuclear power principles. The course language is English at Argonne and Karlsruhe, French at Saclay. A good knowledge of the working language is required.

**Duration.** The duration of the courses is from 12 to 15 weeks with seven to eight hours of dedicated study per working day. Although this is a relatively long period for intensive study, nevertheless it has been found that the morale and interest of the participants remain at a very high level throughout the course. The three-month duration, however, does represent a problem for the nominating organizations and Governments, who often find it difficult to accept the extended absences of badly needed key personnel. The comment has been heard: "we can't spare the men we would like to be trained in these courses; most of those we could spare we are not interested in sending and they would not be qualified".

**Lecturers.** The courses are international not only with respect to participants but also to lecturers. About 80 per cent of the lecturers are from the host country, the rest are IAEA staff members or invited by the Agency from other countries.

Classroom instruction at the Karlsruhe Research Centre, Federal Republic of Germany. Participants in the IAEA nuclear power training course hear lectures from a large number of invited experts, as well as from staff members of the Centre.

Many informal discussions on a one-to-one basis between participants and experts take place during the nuclear power training course.



**Curriculum.** The course programmes are based on the syllabi. About half of the course time is occupied by appropriate lectures and the other half is reserved for discussion sessions, panels, work sessions and technical visits. A certain flexibility is maintained with the purpose of trying to adapt the course content to the needs of the participants as much as possible, without losing continuity of logical sequence.

**Enrollment.** The number of participants in each course is limited. The desired number is 30 to 40 per course. In the first six courses, the 330 applications received exceeded the available places, and all of the qualified candidates could not be accepted. Administrative difficulties have been caused by late nominations and drop-outs.

**Cost.** Detailed planning of a course takes about a year. The overall workload for planning a course is 3 to 4 man-years, not including the preparation of the individual lectures, case studies and workshops. The cost per participant is estimated at the equivalent of US $10 000. The IAEA provides accomodations and a modest stipend; the travel costs of the participants, as a matter of policy, are covered by the nominating organizations or Governments; the financing for running the course is provided by the host Government.

A standing rule against any type of commercial promotion is strictly enforced, in particular in the case of experts making reference to vendor organizations, architect/engineering, or consulting firms. Though experts tend to be enthusiastic supporters of the technologies they know best, every effort is made to provide a fair balance of opinions by presenting different points of view. Problems found in developing countries are emphasized.

There seems to be a continuing yearly demand for holding at least one of each of the power project courses in English. In addition, a Spanish language course is being planned for 1978 on nuclear power project development. It will be offered in Madrid, and will be directed to the needs of professional engineers who are or will be responsible for the execution of nuclear power project tasks assigned to them by top management and policy makers.

A Russian language course is also being planned for 1978, emphasizing the Novovorone-type power plants. It will be directed towards fulfilling the requirements of countries acquiring these units. A schedule of past and future courses is shown in Table 3.

The need for more specialized in-depth courses has been noted, and it is intended to offer some of these, possibly three or four, in 1978. These courses would probably have a shorter duration (4 to 8 weeks) and would be directed mainly to the executive engineer concerned with a particular subject area. Some of them might be regional, others interregional. Possible subjects under consideration are:

- Planning for energy alternatives
- Nuclear power plant site selection
- Regulatory planning
- Contracting and financing nuclear projects
- Safety analysis
- Design and engineering review
- Quality assurance
- Schedule and cost control
- Fuel cycle planning and contracting
- Uranium exploration
- Power plant instrumentation and control
- Training and manpower development
- Operations management
- Nuclear material control and safeguards
- Waste management.

Practical demonstrations as well as theory are offered in the nuclear power training courses. Here participants watch the results of a tension test on concrete reinforcing bars.

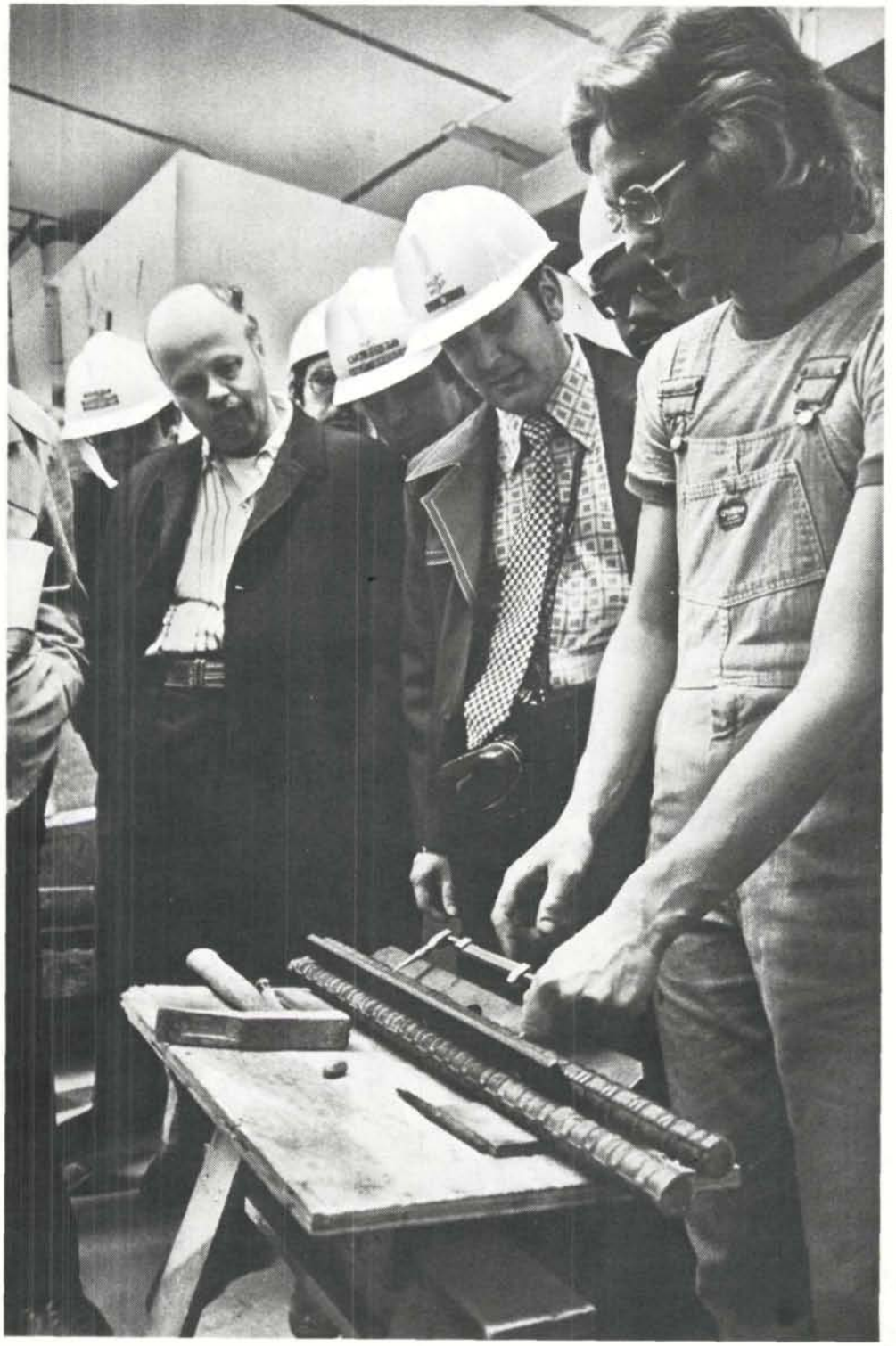


**Table 3**
**Nuclear Power Project Training Courses**

| | | |
|---|---|---|
| 1975 | 8 Sept.–19 Dec. | Planning and Implementation<br>Karlsruhe, FRG, in English |
| 1976 | 6 Jan.–16 Apr. | Planning and Implementation<br>Argonne, USA, in English |
| | 30 Mar.–9 July | Planning and Implementation<br>Saclay, France, in French |
| | 6 Sept.–30 Nov. | Planning and Implementation<br>Karlsruhe, FRG, in English |
| | 8 Sept.–16 Dec. | Construction and Operation Management<br>Argonne, USA, in English |
| 1977 | 18 Jan.–29 Apr. | Construction and Operation Management<br>Argonne, USA, in English |
| | 29 Mar.–8 July | Construction and Operation Management<br>Saclay, France, in French |
| | 7 Sept.–16 Dec. | Planning and Implementation<br>Argonne, USA, in English |
| | 12 Sept.–16 Dec. | Construction and Operation Management<br>Karlsruhe, FRG, in English |
| 1978 and onwards | | According to demand<br>in English, French, Spanish and Russian |

The training of technicians is another activity of the IAEA, and some courses related to nuclear power are being offered and planned.

The nuclear power project training programme has proven to be successful. A considerable number of highly qualified professionals from developing countries have been given the opportunity to learn through direct contact with experts who have had first-hand experience. It is recognized that the courses are not a substitute for on-the-job training, but their purpose is achieved if they have resulted in the transfer of practical, reliable information and have helped developing countries to prepare themselves for the planning, construction and operation management of nuclear power stations.