# Korea's Experiences in Implementing a Nuclear Power Programme

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*This article is taken from the address given by Dr. Lee during the Scientific Afternoon at the 18th IAEA General Conference.*

*In his introduction he referred to his country's successful reconstruction programme after the Korean War (1950–53) and the present stage of industrialization reached during the Third Five Year Economic Development Programme. The country's extraordinary economic growth, Dr. Lee said, required an ample supply of energy, and indigenous resources were stepped up. However, by 1974 approximately 60% of the total energy demand relied on imported oil from the Middle East, and this was expected to increase. As a result, long-term measures for energy supply were drawn up early in 1974, and nuclear power was decided upon to replace thermal power generation fired by imported oil.*

*Dr. Lee expressed the hope that the development stages and problems faced by the Republic of Korea would serve as a means of reference to other developing Member States contemplating the introduction of a nuclear power programme.*

## KOREAN NUCLEAR POWER PROGRAMME

Especially in a nuclear power program, basic policy mistakes can be exceedingly costly due to the capital intensiveness of the nuclear steam supply system. For Korea, with very limited resources of trained personnel and foreign exchange, major mistakes are even more serious than those of industrialized countries.

The preliminary feasibility study of nuclear power generation was started with a handful of staff in the early sixties by the former Office of Atomic Energy (OAE), which was a government agency responsible for the peaceful use of atomic energy in the Republic of Korea. The unit size range contemplated was 200 – 300 MW(e) because of its rather small grid capacity. However, the result of a study showed neither any economic soundness nor that it was the appropriate time for introducing the first nuclear power plant into the system.

In 1967, a comprehensive feasibility study was again undertaken by the OAE. To carry this out, the OAE organized a task force of engineers with some experience in nuclear energy technology from the Korea Atomic Energy Research Institute (KAERI) and from energy industries such as the Korea Oil Company and so on. The unit size considered was larger

than that contemplated in the previous preliminary feasibility study, thanks to the rapid increase in grid capacity. The study showed that the relative economics would favor nuclear power for a unit size exceeding the 500 MW(e) class in Korea by 1974. It is evident that the maximum single unit size depends on the total electric grid capacity, whereas the time of feasible nuclear power generation depends upon the relative economics of power generation. In developing a nuclear power program, the following steps were taken, taking into account several major carefully evaluated factors:

*1. A preliminary assessment of potential sites,* with reference to population density, meteorology, grid interconnections, soil seismic conditions, accessibility for large, heavy components, cooling water availability, etc. Even though in-depth site investigations are costly and time consuming, a large enough number of sites should be considered in advance, in order to avoid future conflict with other industrial site usage and population growth. I would like to stress this point especially for highly populated and rapidly industrializing countries.

*2. A preliminary assessment of proven reactors* in terms of capital and operating cost, fuel cycle analysis and its supply prospect, their construction and operating performance, and the training of Korean personnel. At this stage, national policy objectives are to be taken into consideration to select a reactor type from the point of view of assuring an economical and stable fuel cycle and minimum foreign exchange payments. Most often, the results of techno-economic analysis would turn out to be in contradiction with the national policy objective. In such a case, the national policy objective should be pursued at a little sacrifice of economics.

Throughout the first and second stages of the nuclear power program development, IAEA technical assistance played an essential role in formulating the Korean program by complementing the very limited resources of Korean staff at the appropriate time. The dispatch of special missions or experts to Korea, sponsoring of nuclear power conferences which Korean staff could attend, and the awarding of fellowships were the outstanding examples of IAEA technical assistance which were effectively utilized.

## LEGISLATIVE AND INFRASTRUCTURAL REQUIREMENTS

Korea had to formulate its rules to assure reactor and public safety with only a limited number of trained personnel.

The Korean Atomic Energy Law, licensing regulations and regulatory practices are based on a combination of the American and Japanese systems.

Before implementing a nuclear power program, it is essential that adequate legislative action be taken at the earliest possible stage in order to establish a proper legal framework. Alongside this legal framework, the infrastructure for executing the program has to be set up for appropriate communications and co-ordination among the various governmental agencies such as the Economic Planning Board, the Ministry of Commerce and Industry, the Ministry of Construction etc., as well as control and supervision of the nuclear power project.

In order to assure public health and safety, stringent safety requirements for nuclear power plants have to be enforced.

The objectives of special legislation dealing with nuclear facilities should be:

*1. To provide a regulatory basis for securing a reasonable assurance* for nuclear installations without undue risk to public health and safety, and without any harmful environmental impact. This aspect is covered by Presidential decrees on (a) installation, operation, management etc. of the reactor (b) technical standards and safety measures etc. for reactor facilities and (c) handling of nuclear fissionable and source materials and related facilities.

*2. To ensure adequate financial protection for third parties* in the event of a nuclear accident. This aspect is covered partly by the Nuclear Damage Compensation Law and Implementing decree of Nuclear Damage Compensation Law.

In the long run, it is necessary that the legal framework and infrastructure be somewhat flexible in order to cope with the evolution of safety requirements, licensing and regulatory guides, engineering codes, standards, and practices.

No matter how good the legal framework and infrastructure at hand, the nucleat power program cannot be efficiently implemented without well-trained and experienced staff.

I would like to stress once again the importance of a sound training program well in advance of the need to staff the executive bodies.

For developing countries, especially in the early stages of a nuclear power program, there is always a shortage of well trained and competent personnel. This manpower shortage can be complemented by IAEA technical assistance or by hiring experienced outside consultants. This is the only possible way for countries with very limited trained manpower to cope with a new, highly technical nuclear project.

## EFFECTIVE IMPLEMENTATION OF THE PROGRAMME

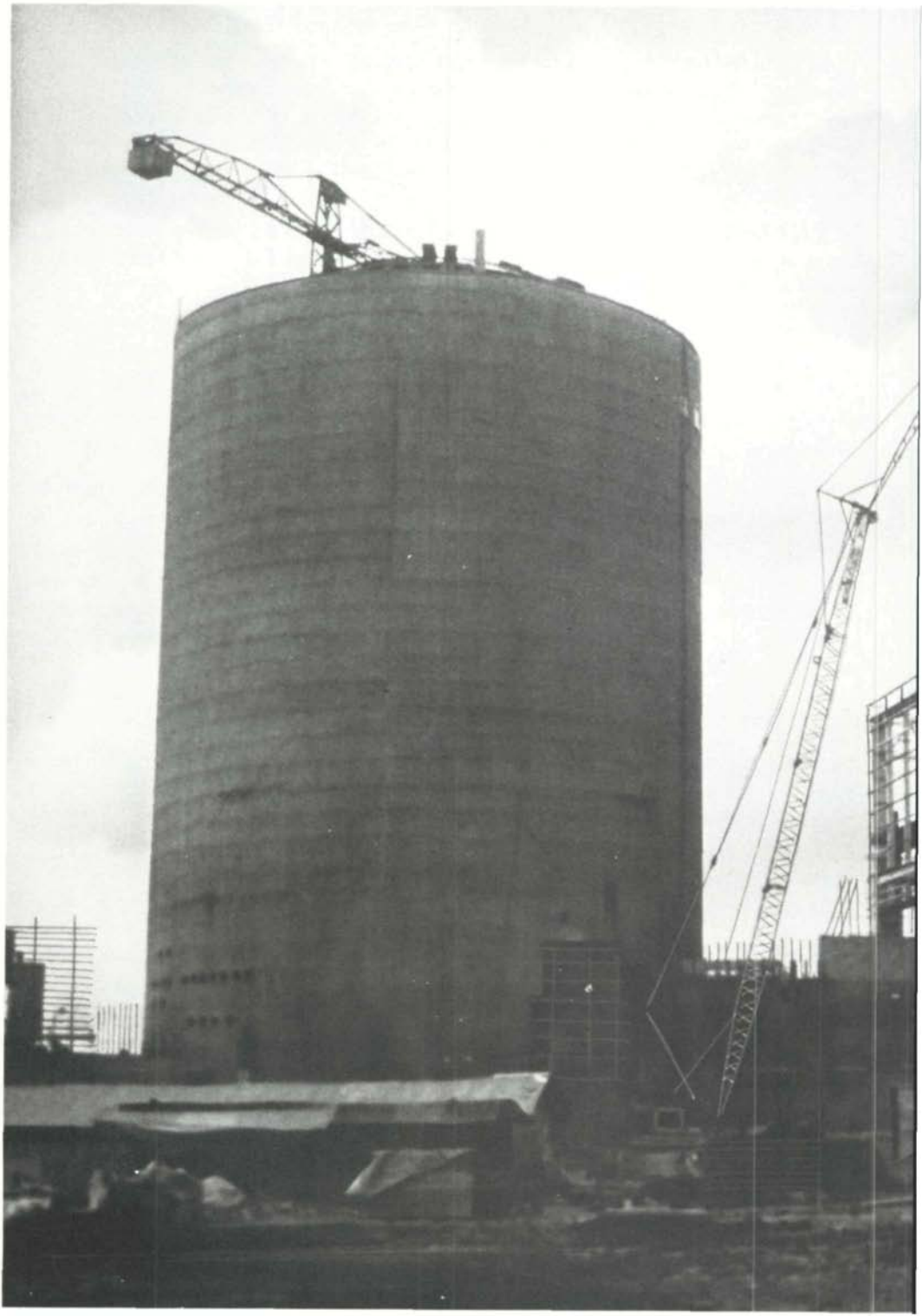
Because of the special nature of a nuclear power project, i.e. stringent safety requirements, every possible measure has to be taken to ensure reactor safety and public health. The steps to assure this are as follows:

1. Training (long term measure)
2. Technical assistance (short term measure)
3. Project management
   Contract management
   Quality assurance

### *1. TRAINING*

A sound training program should be commenced at the outset of the nuclear power program. There are a number of possibilities, depending on the progress of the Project:

a) Project Contract Provisions for:
   Maintenance staff
   Utility and regulatory support staff
   Staffing for subsequent units
b) By outside consultant
c) Participation in vendor activities by home office training and work assignements
d) Technical exchange programs with neighboring countries, such as Japan
e) IAEA-sponsored programs such as fellowships, scientific visits and seminars.



The first Nuclear Power Station in Korea, the reactor Ko-Ri, under construction.

## 2. TECHNICAL ASSISTANCE

Since the utility will not have an expert staff, various methods to augment their capabilities must be employed. This is the area where the IAEA, or an outside consultant's technical assistance can be utilized most effectively by:

a) General consulting contract for specific problems covering the regulatory agency and the utility.
b) Consultation by resident experts at the home office as well as at the site in the following areas: (i) Mechanical Engineering, (ii) Fabrication Engineering, (iii) Instrumentation and Control and Electric Power Engineering, (iv) Civil Engineering, (v) Reactor Physics and Fuel Cycle Economics.

## 3. PROJECT MANAGEMENT

Prior to the project contract, there are a number of preparatory steps, such as (a) feasibility study (b) bid preparation and invitation (c) evaluation of bid proposals (d) negotiation of contract terms and conditions (e) supply contract and financial agreement, etc. Throughout these processes, the ability of the utility's or government agency's own staff to make their own judgement, is most essential to manage the project in a sound manner.

Even though you may be assisted by an outside consultant, the final decisions rest entirely on your judgement. Therefore, the utility as well as the government agency have to be staffed with a minimum number of well-trained personnel who may not have previous experience, but can make proper judgements. Especially during the licensing review in Korea, the actual review was done by the Advisory Committee on Reactor Safety (ACRS) with the support of the Korea Atomic Energy Research Institute (KAERI). Of course, it is ideal to have enough technical staff in the government regulatory agency so that the actual technical review can be made by them without outside help. Until such time that the regulatory agency has enough technical personnel to make sound judgements, the maximum utilization of ACRS and the technical capability of KAERI must be made.

With regard to the type of project contract, a "Turnkey" contract with maximum participation of your own engineers would be advisable only in the case of the first nuclear power project. Even in the case of a "Turnkey", the maximum effort should be made to participate in every possible area of project management. This is very important in looking ahead to a subsequent unit and to increase the share of domestic participation in order to reduce foreign exchange payments in the future. As the capability of the staff builds up, the project management should change from "Turnkey" to "Owner management". This is essential, not only from the viewpoint of reducing the project cost, but to build up the operational and maintenance capability of the reactor staff for commercial operation.

As soon as the project moves into actual construction, the Quality Assurance (QA) of the project becomes important. The most vital part of a utility QA program can be a resident expert who can also serve in a training capacity. This expert should be considered only at the very first step in establishing an acceptable QA program. In order to expediate an active QA program, our own staff from the Atomic Energy Bureau, KAERI and Korea Electric Company (KECO) are actively engaged in on-the-job training at the site, and render some help on QA activities.

Other important aspects of an initial nuclear program include the review by difference, and good communication between the various organizations concerned with the nuclear project.

The review by difference should include a comparison between the plant being constructed and other similar plants, and the reasons for any differences. It must be in sufficent detail and include all of the important structures, systems, and components. This review approach has several distinct advantages. Firstly, becoming familiar with the complex systems can serve as an important means of training for both utility and regulatory staff.

Secondly, when the comparison is carried out not only with the reference plant (usually specified in the project contract), but also with a more recent plant, it can serve as a means of following new developments. In the area of communication, meetings between the various organizations involved in the project must be held at regular intervals to ensure an effective exchange of information, and in some cases, to maintain a sustained effort. In addition to the on-going discussions between prime contractor and utility, a minimum of weekly meetings between the utility and regulatory agency, bi-weekly meetings between the last two and the prime contractor, and monthly meetings involving the safety advisory committee, must be held. Additionally, at least an annual general safety review meeting and periodic topical meetings should be arranged.

## CONCLUDING REMARKS

I have tried to touch upon various important aspects based on our experiences in implementing the program. In conclusion, I repeat that to successfully implement a nuclear power program, a well-trained and qualified staff is essential. This need must be recognized early, and adequate provisions for training and financing must be included in the project contract.

As a short-term measure for successful implementation: IAEA missions and experts or foreign consultants to be fully utilized in complementing your own staff capability, whenever and wherever the need be recognized, along with a short-term on-the-job training program of your own staff.

As a long term measure: the IAEA fellowship program, and a manpower training program through bilateral agreement, can be exploited.

On the other hand, as a means of technical assistance, safety standards, engineering codes and standards, and design criterias for a number of proven reactor types could be reviewed carefully and somewhat standardized by the Agency staff. As a results of these reviews, the IAEA could recommend the developing Member States safety standards and design criteria so as to reduce safety review efforts. This type of IAEA assistance to the Member States would be of great help, especially to those developing countries with limited resources and trained manpower. Assistance in this form would not only bring economic gain, but also give greater confidence and impetus to developing countries in their first endeavors to gain the experience to introduce nuclear power. Funds spent for this purpose would surely result in safer and more reliable nuclear power plants throughout the world.