DEVELOPMENT OF NUCLEAR POWER

An extensive discussion of problems concerning the development of nuclear power took place at the fifth regular session of the IAEA General Conference in September-October 1961. Not only were there many references in plenary meetings to the nuclear power plans of Member States, but there was also a more specific and detailed debate on the subject, especially on nuclear power costs, in the Program, Technical and Budget Committee of the Conference.

The Conference had before it a report from the Board of Governors on the studies made by the Agency on the economics of nuclear power. In addition, it had been presented with two detailed documents, one containing a review of present-day costs of nuclear power and the other containing technical and economic information on several small and medium-sized power reactors in the United States. The Conference was also informed of the report on methods of estimating nuclear power costs, prepared with the assistance of a panel of experts convened by the Agency, which was reviewed in the July 1961 issue of this Bulletin.

Review of Costs

The document containing latest data on the costs of nuclear power generation is a revised edition of a similar paper presented at the fourth (1960) session of the General Conference. The new edition includes much additional information on the components of fuel costs and on small power reactors which may be particularly suitable for the less developed countries.

The cost data have been obtained from six countries: the United States, the United Kingdom, France, Canada, Japan and the Federal Republic of Germany. The data are based on present designs and technology. All data have been arranged in a uniform manner so as to permit easy comparison.

It is pointed out that although the uncertainty as to the general applicability of specific information on nuclear power costs has somewhat decreased during the past year, it must still be borne in mind that with the comparatively recent advent of this kind of power, only limited operating experience has so far been gained and hence much of the technical and economic data at present available represent considerable extrapolation from actual experience. The quantitative values given in the document may, therefore, be subject to substantial reassessment as the technology develops. The methods of calculating nuclear power costs also differ widely from one country to another. Furthermore, it is not always possible to make a valid comparison of construction costs in different countries simply by applying the official rates of exchange for their currencies; the ability or inability of a country to manufacture all or some of the plant components may have an important economic bearing.

Analyzing the available cost estimates, the document notes that in the United Kingdom nuclear power, generated from large gas-cooled reactors, is likely to be competitive with conventional power in about five years' time. The forecast for the United States, based on certain stated assumptions, is that power generated from a large nuclear plant constructed towards the end of this decade will be competitive with conventional thermal power in areas where conventional fuel costs are relatively high.

Commenting on future trends, the document envisages important reductions in costs as a result of the continuous research and development which is now in progress. Reductions in fuel cycle costs will be especially important. Considerable savings are also expected from improvements in reactor materials, standardization of reactor components, simplification of safety measures, and the spreading out of engineering development expenses as a result of the building of similar plants on a larger scale.

US Small Reactors

The report on small power reactor projects in the USA was prepared by members of the Agency's technical staff after a series of visits to the reactor sites, discussions with officials and scientists associated with the projects, and a study of all available information on their technical, economic and administrative aspects. This followed a US offer inviting the participation of the Agency's technical staff in the design, construction, start-up and operation of a 20 MW pressurized water power reactor and other similar projects in the USA. Following subsequent discussions, it was felt that it would be more profitable for the Agency to follow essential aspects of several power reactor projects under way in the United States, and the US Government broadened the scope of its original offer to enable the Agency's staff to obtain comprehensive information on several other small reactor projects under the Power Reactor Demonstration Program of the US AEC.

The report prepared by the IAEA experts concentrates on four projects and briefly describes the status of a few others. Further reports may be prepared as the work develops. The object is to place the collected information at the disposal of all Member States of the Agency.

The four reactors on which detailed information is contained in the report are:

(1) The Elk River boiling water reactor in Minnesota. (This reactor will have a thermal output of 58 MW, supplemented by 14 MW from a coal-fired superheater, to give a net electrical output of 22 MW. The novel feature of this reactor is the use of a mixture of thorium and uranium as fuel.)

(2) The Piqua organic moderated reactor on the east bank of the Miami River. (This 11.4 MW (electrical) reactor, which will supply steam to an existing turbine of the Piqua Municipal Power Station, is the first commercial organic moderated power reactor and will serve as a prototype of a medium-sized nuclear power plant.)

(3) The BONUS boiling water reactor in Puerto Rico. (This reactor, which will have a net electric output of 16.3 MW, is being constructed on the western tip of Puerto Rico under the US AEC's program of demonstrating the technical and economic feasibility of integral nuclear superheat.)

(4) The Pathfinder boiling water reactor on the south bank of the Big Sioux River. (This reactor, which will have a net electric output of 62 MW, is intended to demonstrate the technical and economic feasibility of an integral nuclear superheat in the central power station. It will be the first full-scale superheat power reactor.)

The report points out that the small power reactor projects in the United States have two main objectives. As reactor experiments, they provide basic technical data needed for large nuclear power plants, and as power producers optimized for small sizes, they furnish information regarding their potential competitiveness with conventional plants in high fuel cost areas in the country.

So far as the first objective is concerned, it is pointed out that before constructing a large nuclear power plant, it is useful to build a small prototype or an experimental reactor to obtain the necessary data on the design and operating characteristics. But the small reactors are not always just a step towards bigger ones. There are a large number of small public utilities in the USA which have a distinct need for small power plants, and there are certain similarities between the Rural Co-operatives in the USA and power companies in some of the less developed countries, inasmuch as both have small systems requiring small units, low load factors and low capital charges. It is felt that the experience gained with small power reactors in the USA, both in their technical and economic aspects, will be of interest to the less developed countries where the installation of small nuclear power plants may be contemplated because of high costs of conventional fuels.

Trend Towards Lower Costs

In the Program, Technical and Budget Committee of the General Conference, Mr. Pierre Balligand, the Agency's Deputy Director General in charge of Technical Operations, pointed out that available information indicated an encouraging trend towards lower costs for nuclear power. It was true that the cost price of reactors had often been higher than originally estimated, but the output had also been greater. For certain known types of reactors, commercial firms could now give fixed prices. It had recently been announced that the cost of nuclear power produced by boiling-water reactors in the 300-400 MW range would soon be competitive with conventional power. Mr. Balligand also noted that forecasts of a decrease in the price of uranium had been confirmed; the US AEC had reduced its prices and it was expected that fuel fabrication costs would also decrease through mass-production methods. The thermodynamic efficiency had not yet reached an optimum value, but greater care and present research on superheating would certainly give better results. The achievement of a thermal efficiency of 40 per cent was expected in an advanced type of sodium-cooled reactor currently under design. Further progress depended on improved industrial methods in the advanced countries.

The experience already gained in several countries was described by their representatives who participated in the discussion in the Committee.

The British representative said that in the United Kingdom the capital costs of gas-cooled graphite-moderated civil power stations had fallen considerably. Two of them, with a rating of 300 MW and a cost of £160 per kW, were now critical. Tenders had been accepted for stations of double that rating, and the estimated cost had fallen to about £100 per kW. Fuel costs were also expected to fall. The IAEA review, the UK representative noted, stated that nuclear power might become competitive with conventional power in Britain by about 1966. More recent information, however, suggested that it might not occur before 1970.

The Canadian representative pointed out that his country had concentrated mainly on a system using heavy water as both moderator and coolant, and natural uranium as fuel. A 20 MW prototype power station of this type was expected to come into operation soon, while construction of a full-scale 200 MW power station at Douglas Point, Ontario, was well under way. It was expected to generate power in the range of 6-7 mills per kWh under the conditions of a Canadian public utility in which it would operate from 1964. This would show that competitive nuclear power was within reach even in a country with a relatively small population like Canada, where the cost of conventional power was usually considered low.

The United States representative said that although nuclear power programs had been deferred in several countries, it seemed certain that nuclear power would provide an important and expanding supplement to conventional sources of power. That was likely to take place in the USA by the 1970's and 1980's, and much earlier in certain other parts of the world. Continuous efforts were being made to reduce further the cost of nuclear power. New and improved reactor designs were being explored, and advances were being sought in engineering, metallurgy and other technological areas. The US delegate also announced that the US Government was prepared to accept a limited number of Agency-financed trainees for on-the-job training in the construction and operation of small and medium power reactor projects.

The Czechoslovak delegate gave an account of the progress made in his country on the construction

of a demonstration industrial atomic power station with a gross capacity of 150 MW. The plant would have a natural uranium reactor, moderated by heavy water and cooled by carbon dioxide gas. The Czechoslovak delegate added that the specific heat output of this type of reactor (20 kW per kilogram of fuel) was comparable with that of reactors moderated and cooled by heavy water, but the gas coolant permitted the use of cheap materials for cladding the fuel elements as well as for the equipment for primary circuits. While the construction cost experience would not be considered typical, it was desirable to develop operational experience, particularly with reference to fuel performance.

National Surveys

The discussion in the Committee revealed that several other countries were contemplating nuclear power programs, and quite a few national surveys of nuclear power prospects had been carried out or undertaken.

The Philippine delegate was happy to note that the Agency had assisted two countries, one of which was his own, in surveying the prospects of nuclear power generation. He considered it encouraging that his Government's preliminary views on this subject had been substantiated by the report of the Agency's Survey Mission, which indicated that in the 1967-68 period a nuclear power plant in the Manila area might be competitive over its lifetime with an oil-fired station of the same size.

The representative of Finland said that the survey of nuclear power prospects in his country, carried out by the Agency together with Finnish experts, had been a most useful exercise and he hoped that the study would prove useful to other Member States having similar problems.

The Pakistan delegate disclosed that a survey had been made in his country by a US firm of consultants engaged for this purpose by the Pakistan Government. The report of these consultants would be submitted to the Agency for review, guidance and technical assistance.

The South African delegate stated that a survey had recently been undertaken in South Africa. He pointed out that a careful study of local conditions by each country was essential and with this background information the data collected by the Agency could be more easily related to a specific situation.

The Korean delegate said that nuclear power appeared to be the only answer to future power problems in his country and it was hoped to install a medium-sized nuclear power plant by 1970.

The representative of Yugoslavia stated that studies made in his country on the effect of including nuclear stations in the power net-work had led to the conclusion that the use of conventional sources would have to be modified. Studies were also being made of the implications for the national economy of different fuel cycles and types of reactors, and a number of problems obviously had to be examined before a nuclear development policy was framed.

The Polish delegate observed that although there was an adequate supply of conventional fuel in Poland, his Government foresaw the day when nuclear power plants would become economically attractive.

Factors in Power Economics

The Australian delegate pointed out that the generating cost of electricity, which represented only a fraction of the cost of power to the consumer, was not the sole factor in power economics. The cost of distribution and the cost of administering a supply service must also be taken into account in the formulation of policy.

The Indian representative cautioned against over-stressing the factors that operate against an economic use of nuclear power in the less developed areas. He pointed out that the lower wage rates in the less developed countries were an important factor in reducing operation and maintenance costs. Referring to the problem of investment in a nuclear power program, the Indian delegate stated that a less developed country should also bear in mind the investment required to increase the production of conventional fuel and to transport it to distant areas. And if a country had to import fuel anyway, the lower cost of nuclear fuel might result in a foreign exchange saving that would offset the initial requirement of foreign exchange for installing a nuclear plant.

The representative of the Federal Republic of Germany referred to the difficulty of comparing cost data from different sources, and suggested that the Agency should concentrate on standardizing known methods of cost evaluation rather than on developing new ones. The Argentine delegate suggested that the Agency should follow up its cost studies by obtaining actual statistics. The French delegate said that France had communicated to the Agency details of construction costs and would soon be able to provide the first data on operating costs.

International Co-operation

All the speakers in the debate stressed the value of the studies made by the Agency. Some delegates urged that the Agency should assume an even more positive role in the field of nuclear power than it had hitherto done. A specific suggestion related to international co-operation for developing nuclear power projects and was put in the form of a resolution introduced jointly by nine countries (Brazil, Finland, Ghana, India, Indonesia, Iraq, Pakistan, the United Arab Republic and Yugoslavia). The resolution, which was approved by the Committee and later adopted by the General Conference at a plenary meeting, refers to the Agency's statutory provisions in regard to the development of nuclear power, the importance of the development of energy resources, the limited resources of conventional power in some of the developing countries, and the early likelihood of making

nuclear power economically feasible through technological means. It then requests the Agency's Board of Governors and the Director General:

(a) to provide, on request, technical advice and guidance to Member States that are desirous of embarking on nuclear power programs, and to facilitate and arrange the direct participation of technicians and engineers of those countries in the design, construction and operation of nuclear power projects;

(b) to render, on request, such assistance as may be possible in the implementation of the nuclear power programs of such States;

(c) to consider the desirability of promoting the establishment of regional nuclear power projects on the basis of international collaboration between the technically advanced countries and the developing countries in the regions concerned, with a view to studying nuclear power costs under conditions prevailing in such regions;

(d) to undertake, on request, studies of the problems of the design, construction and operation of international demonstration nuclear power plants, and to consider the desirability of the establishment of such plants; and

(e) to report to the General Conference at its sixth regular session on the action taken in regard to the above matters.

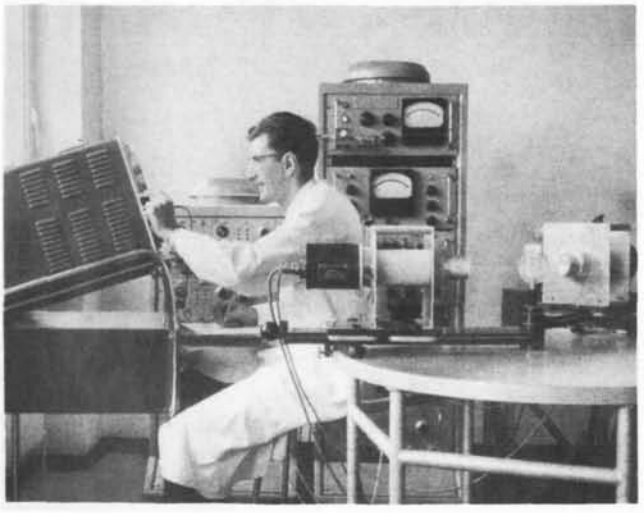
WORK BEGINS AT SEIBERSDORF LABORATORY

With the start of work at its laboratory at Seibersdorf, some thirty kilometers from Vienna, the International Atomic Energy Agency has entered upon a new phase in its development. Although some laboratory work had been carried out at the Agency's headquarters for quite some time, it was only with the completion of the facilities at Seibersdorf last autumn that the Agency could undertake its scientific research functions on an adequate scale. The establishment at Seibersdorf is the world's first full-fledged laboratory of a truly international character.

Although the laboratory is a rather modest one in comparison with national atomic energy establishments (especially in the advanced countries), it is in a unique position to carry out certain distinct tasks which call for comparison and co-ordination on the widest possible basis.

The nature of these tasks was outlined by the Agency's General Conference which, at its session in 1958, recommended that the scope of the laboratory should be limited to the following broad functions:

In the standardization section, Mr. Manuel Miguel, of France, one of the laboratory scientists, working with gamma-gamma coincidence apparatus



The recorder of an anti-coincidence counter being adjusted by Dr. O. Suschny, of Austria, head of the environmental radioactivity section