A MISSION TO THE FAR EAST

At the request of the Governments concerned, the International Atomic Energy Agency sent a preliminary assistance mission to five countries in the Far East last summer. The mission, which consisted of six members*, went to the Philippines on 24 May 1959 and later visited the Republic of China, the Republic of Korea, Japan and the Republic of Viet-Nam, returning to Vienna on 11 July 1959. It spent several days in each of the five countries, studying and discussing how their atomic energy programmes could develop and how the Agency could assist in that development. The information obtained and conclusions reached are recorded in the mission's reports, the main points of which are summarized below.

One of the tasks of the mission was to study how the atomic energy activities in the five countries are organized. The Atomic Energy Commission of the Philippines was established in 1958 and is responsible to the National Science Development Board. A Nuclear Research Centre, to be located near the University of the Philippines, will function under the control of the Commission. In Taiwan, the body responsible for atomic energy activities is known as the Atomic Energy Council, and nuclear research work is performed by the Institute of Nuclear Science at the Tsing-Hua University, located 45 miles south west of Taipei. In Korea, an Office of Atomic Energy was established in January 1959 and will eventually consist of an Atomic Energy Commission, an Atomic Energy Research Institute and a Bureau of General Affairs. The Commission has not yet been created; the Research Institute was in the process of being built near Seoul at the time of the mission's visit. In Viet-Nam the Office of Atomic Energy, created in October 1958, is responsible for all atomic energy activities and is planning to establish a Nuclear Research Institute near Dalat. The Atomic Energy Commission of Japan was established four years ago. The executive and secretarial organ of the Commission is the Atomic Energy Bureau, while the central research body for the development of atomic energy is called the Japan Atomic Energy Research Institute.

Education and Training

The University of the Philippines has been rebuilt and well equipped after the second World War. At present, nuclear science is taught at the University under the direction of a foreign adviser. A radioisotope techniques course is conducted by the Philippine Atomic Energy Commission but the facilities and equipment are inadequate. The Agency, the mission thought, could help by providing equipment, fellowships, and an expert for a radiochemical course.

In Taiwan, training in nuclear science is given at the Tsing-Hua University through the Institute of Nuclear Science, but the recruitment of teaching staff is a difficult and urgent problem. In the opinion of the mission, the Agency could assist by providing fellowships and the services of visiting professors.

The Seoul National University in Korea is still under reconstruction. Nuclear science is not taught in the country at present, but it is planned to do so when the Atomic Energy Research Institute starts functioning. The mission felt the country would need to devote as much effort as possible to improve the level of instruction in the university, particularly in the basic sciences. As regards overseas training, high priority should be given to electronics, health physics, application of radioisotopes to medicine and agriculture, radiochemistry and neutron physics.

In Viet-Nam, the Faculty of Science of Saigon University is faced with three main problems: shortage of funds, shortage of teaching personnel, and lack of facilities for basic training and research. No training in nuclear science is being conducted in the country, but several Vietnamese are working in the nuclear field abroad. The mission was of the opinion that the availability of a sufficient number of trained people should be assured before work began on the proposed nuclear research centre. The Agency could assist by granting fellowships.

Of the 231 universities in Japan, 53 have set up courses for training in different branches of nuclear science; Tokyo University has established an institute for nuclear studies, and an electron synchrotron of 1 BeV is under construction. The Japan Atomic Energy Research Institute provides training in nuclear engineering and in the uses of radioisotopes. Although Japan has excellent facilities and a high quality of basic scientific training, the mission thought it might be able to use the assistance of the Agency for fellowships in advanced training, for experts in specialized fields, and for visiting professors to conduct advanced courses. Japan itself could help the Agency by providing fellowships and visiting professors for other countries and by making its extensive facilities available for international or regional training courses.

Reactors

A 1 MW swimming pool reactor is under construction near the University of the Philippines and is expected to be ready by the end of this year. The

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* *The mission was led by Harold Smith, a senior member of IAEA's Division of Isotopes and a specialist in the biological effects of radiation and the application of atomic energy in agriculture. The other five members were Arturo Cairo, Munir Khan, Ole Pedersen, Herbert Vetter - all members of the IAEA staff, and John Webb, who was until recently the Principal Field Engineer of the Australian Atomic Energy Commission and now belongs to IAEA's Division of Technical Supplies.*

mission felt that in order to help plan the reactor programme and to ensure its safe and effective utilization, the country needed the services of an overall planner of atomic research programmes, a reactor health physicist and an experimental physicist.

A 1 MW swimming pool reactor is also being built at the Institute of Nuclear Science of the National Tsing-Hua University in Taiwan and is expected to go critical by next April. The Institute has a 3 MeV Van de Graaff accelerator, while nuclear engineering and radioisotope laboratories are being planned. The services of a reactor health physicist and an experimental physicist will be needed for the reactor; later the need will also arise for a radiochemist and a reactor operations expert.

At the time of the mission's visit to Korea, a 100 kW Triga Mark II reactor was nearing completion at a site adjacent to the Engineering College of Seoul National University. The reactor, which will be a part of the Atomic Energy Research Institute, will also need the services of a reactor health physicist and an experimental physicist.

In Viet-Nam, a 100 kW Triga Mark II research reactor is to be built at Dalat as part of the proposed Institute of Nuclear Research. On the question of a specific site for locating the reactor, the mission told the Vietnamese authorities that there should be sufficient area available for future expansion and that the reactor should be located where natural drainage was away from the city water supply in order to avoid possible hazards resulting from any inadvertent discharge of radioactive waste.

The mission was impressed by the high level of nuclear research being carried out at the Japan Atomic Energy Research Institute and the Atomic Fuel Corporation at Tokai Mura and at other research centres. JRR-1, the first Japanese research reactor, a 50 kW water boiler, went into operation in 1957, and the mission was informed that JRR-2, a CP-5 type 10 MW reactor, would be ready by the end of 1959. JRR-3, a 10 MW natural uranium heavy water-moderated reactor, designed and built by Japanese scientists and technicians, will be ready this year. Current plans indicate that Japan will have a total of six research reactors in operation by this year. The mission felt that the Agency should consider awarding research contracts to institutes in Japan.

Isotope Applications

In the Philippines, atomic energy techniques are being used to a small extent in soil fertility tracer studies, and there are other plans to develop projects using radioisotopes. One of the difficulties, however, is a lack of trained personnel, and a programme of fellowships to train agricultural specialists is essential. The mission considered it advisable that the main development in the agricultural uses of atomic energy should take place at established centres for agricultural research, and the programme should be so designed as to supplement conventional methods.

A senior member of the Japanese Atomic Energy Research Institute explaining progress and plans to members of the IAEA mission during their visit to the research centre at Tokai-Mura, about 100 km north of Tokyo

For medical applications, there are three radiocobalt units in operation in the Philippines and a fourth one was being installed at the time of the mission's visit. These units are fully and efficiently utilized by experienced radiologists, but are still unable to cope with the heavy patient load. Work with unsealed radioactive sources is confined to the Philippine General Hospital in Manila, where a very wide range of activities are carried out, including clinical research and diagnostic studies as well as therapy. There is a high incidence of goitre among the people of the Philippines, and research with radioiodine to discover its causes would be useful.

In Taiwan, the use of atomic energy techniques in agriculture is under way at several centres; further development of these projects could be encouraged through the Agency's fellowships and research contract programme. The Agency could also assist a course on the use of radioisotopes in agriculture planned to be held at the College of Agriculture of the National Taiwan University.

A radiocobalt teletherapy unit is in operation at the National Taiwan University Hospital, and the mission found that another unit had arrived and was to be installed at the Provincial Taipei Hospital. The mission felt that further radiocobalt units should be installed in the near future, if sufficient trained personnel could be found. At the radioisotope laboratory at the National Taiwan Hospital, the interest was concentrated on the diagnosis and therapy of thyroid disease, and a study had been made with radioiodine on the causes of endemic goitre in school children. The activities of the laboratory were soon to be extended to certain other fields of investigation.

Although very little research is at present being conducted in Korea on the uses of radioisotopes in agriculture, a growing number of scientists are receiving training abroad in this field. With the return

of some of these trained investigators, a radioisotope research laboratory is being planned. The use of atomic energy techniques in agriculture could best be encouraged through Agency fellowships, through subsidizing agricultural research with funds from the Korean Office of Atomic Energy, and through equipping a radioisotope laboratory for agricultural research.

There is a shortage of radiotherapy equipment in Korea, and no immediate plans for setting up further machines have been made. An obvious place for installing a radiocobalt unit would be the National Medical Centre in Seoul, which has been built with aid from Denmark, Norway and Sweden. Plans for adding a radiotherapy department to the Centre are being considered, and the mission discussed a possible scheme for co-operation in this matter between the Agency, the Scandinavian Medical Board and the Korean Government. Work with unsealed radioactive sources is carried out on a limited scale in the College of Medicine of Seoul National University.

No agricultural research with atomic energy techniques is now being done in Viet-Nam. Since use of these techniques requires a relatively high level of conventional research, the mission thought that for the immediate future investigations using radioisotopes could be used to greatest advantage at the Rubber Research Station in Laikhé.

Medical applications, too, are still to be introduced. There is a definite need for radiotherapy facilities, and plans have been made for setting up a radiocobalt teletherapy unit at the National Cancer Centre which is being built in Saigon.

Japanese scientists are conducting investigations on most of the main applications of radiation and radioisotopes in agriculture, at about 12 different institutions. The mission felt that the Agency could be of assistance by helping to finance research projects through its research contract programme. On the other hand, Japan is in a position to assist the Agency through the placement of Agency fellows in its Radioisotope School and in institutions for agricultural education and research.

There are about 300 hospitals in Japan using isotopes for clinical research, diagnosis and therapy. About 100 low-activity radiocobalt units built within the country are in operation, and units with up to 200 curie source strength are now being put on the market. Unsealed radioactive sources are widely used and the clinical isotope laboratories which the mission saw were well equipped, mostly with Japanese instruments. It appeared, however, that with a few exceptions, clinical research work had only partly contributed to the astonishing recovery of science generally in Japan after the war. The situation could, however, improve greatly once the construction of the National Institute of Radiological Science at Chiba City was completed, because, among other things, this would result in the establishment of a hospital equipped with the most modern facilities for medical radiation work, including advanced clinical research.

The mission also noted that radioisotopes are used in Japan on a large scale in industry, and a great number of instruments and equipment used in this connexion are produced within the country.

Raw Materials

There is a need in the Philippines for an organized effort in the search for nuclear raw materials. The mission felt the interest of the Atomic Energy Commission could be stimulated by giving it greater authority in this field, and one of its officers should initiate exploration in conjunction with the Bureau of Mines and private industry. The mission also thought that the country could ask the Agency for an expert in aerial survey methods for uranium prospecting. Proposals for fellowships should be supported by the Agency, particularly if they were for training in uranium geology, mineralogy and prospecting methods.

Taiwan has a good organization for mineral prospecting and is well equipped to carry out exploration for nuclear raw materials. Substantial reserves of thorium and zirconium have been established but economic deposits of uranium have not yet been discovered. The need for nuclear materials in Taiwan is, however, in the distant future, since in the early stages it is planned to obtain nuclear raw materials from overseas and the first commercial power reactor is not contemplated until at least 1968. Nevertheless, this should not prevent exploration for these minerals from being continued on a more intensive basis in the immediate future.

Korea is fortunate in possessing large quantities of monazite and accompanying zircon, both of which might be important in an atomic energy programme. The geology of the country is favourable for the occurrence of uranium minerals, and prospecting for uranium and beryllium should be encouraged. Regarding a Korean proposal to expand monazite production, the mission pointed out that monazite would be important only if current work on thorium breeder and converter techniques was successful and if the thorium fuel cycle compared favourably with a fuel cycle based on uranium.

The geology of a large coastal area of Viet-Nam is very promising for uranium occurrence, and the mission recommended that the country's atomic energy programme should include the prospecting for minerals, such as thorium and beryllium. A serious deterrent to successful prospecting is the shortage of qualified men, and assistance by the Agency in providing fellowships in geology, prospecting and metallurgy would be appropriate.

Japan has an adequate and efficient organization for the exploration, mining and treatment of uranium ores to the point of uranium metal production. In an incredibly short time extensive surveys for radioactive minerals have been carried out by aerial means and car-borne equipment. More attention could profitably be given to other nuclear raw materials,

particularly ores of beryllium, the occurrence of which is geologically promising.

Nuclear Power

The total installed electrical capacity in the Philippines in 1958 was 414 MW corresponding to 0.0172 kW per capita, and the annual consumption was 72 kWh per capita. The country has a hydro potential of 2 250 MW, of which only ten per cent has been developed so far. A ten-year plan calls for constructing 1 174 MW of hydro capacity by 1968. The fossil fuel reserves consist of 63 million tons of coal scattered over several islands, and no significant deposits of oil or gas have been found so far. The present steam plants use imported oil. There are no immediate plans for nuclear power, but a nuclear power study group has been established to investigate the economics of nuclear power compared with conventional power. There may be a possibility of constructing a nuclear plant by 1968. The mission recommended that the relative economics of nuclear and oil-fired thermal plants should be carefully studied to determine the opportune time for the introduction of nuclear power.

In Taiwan, the installed capacity at the end of 1958 was 580 MW corresponding to 0.058 kW per capita, and the consumption was 288 kWh per capita. In 1962 the installed capacity is expected to be 1 000 MW. Considering the available conventional resources there is no immediate need for nuclear power. The estimates of the total hydro potential vary from 1 000 to 1 500 MW firm capacity, out of which approximately one tenth has been developed so far. The coal deposits, mostly in the northern part, are estimated at 150 and 200 million tons. Consideration is being given to plans for installing a 100 - 150 MW atomic power plant in the Kao-Hsiung industrial area by 1968. As a first step, the country has indicated a desire to construct a small experimental power reactor in the near future in order to gain the necessary experience and train personnel. The mission urged that first priority should be given to the development of hydro power and thermal stations using local coal, and that the question of installing an atomic power plant should be decided on the relative economics of nuclear and conventional power. It agreed, on technical grounds, on the desirability of setting up a small experimental power reactor but pointed out the high cost involved in this project.

Korea's installed capacity in 1958 was 372 MW corresponding to 0.017 kW per capita, and the annual consumption was 69 kWh per capita. There is no immediate need for nuclear power because of existing conventional power resources. The hydro potential is estimated at 640 MW firm capacity, out of which 80 MW have been developed so far. The known coal deposits are nearly 625 million tons, but the quality of coal is not good. In general, Korea is poor in fuel resources and the use of atomic power as a supplement to other sources is indicated for the future. The country is considering the possibility of constructing a 75 MW nuclear power plant in 1968. Here again, the mission advised a detailed and comparative analysis of the economic factors involved.

The installed capacity in Viet-Nam in 1958 was 119 MW, corresponding to 0.0095 kW per capita, and the annual consumption was 24 kWh per capita. The reserves of energy from fossil fuel are very low; there are no known reserves of oil and natural gas and the reserves of coal amount to only three million tons. There is, however, no pressing need for nuclear power in the immediate future because the hydro-electric potential of the country, amounting to about 1 500 MW, remains virtually unexploited. In the opinion of the mission, development of hydro-electric power should receive first priority, while the possible role of atomic energy should be kept in view in long-term planning.

Japan has an installed capacity of 17 000 MW corresponding to 0.185 kW per capita. The present rate of annual consumption is 840 kWh per capita, the highest in Asia. Japan is keenly interested in the early development of nuclear power because suitable sites for hydro-electric power stations are becoming scarce and indigenous coal production is not sufficient to meet the requirements on an economic basis. The country is already building one 160 MW (E) Calder Hall advanced type reactor to be ready in 1963, and a 11.7 MW (E) reactor, of the boiling water type, will be completed in 1962. According to a plan worked out in 1957, the nuclear power capacity in Japan will be a maximum of 600 MW in 1965, 3 000 MW in 1970 and 7 000 MW in 1975. To carry out this extensive atomic power programme Japan will have to import large quantities of fissionable material of which it produces very little. The mission drew the attention of the Japanese authorities and of private organizations to the possibilities of continued procurement of fissionable material through the Agency.

The reports of the mission also contain certain observations on the need for health physics and radiation protection regulations. Except in Japan, little has been done in this field in the countries visited by the mission. The mission urged the authorities concerned to pay adequate attention to the health and safety aspects of atomic energy activities and establish appropriate measures. In Japan, however, extremely stringent regulations have been brought into force and a great deal of scientific effort is being devoted to problems of radiation effects and radiation protection.