collected by the national authorities and gather additional information that may have a bearing on cost factors. It will assess the progress made in the generation of electricity in the vicinity of the proposed locations, assist in making a preliminary assessment of future power needs and suggest steps for meeting those needs. In particular, it will consider the special problems of installing nuclear power plants at the suggested locations.

The survey in Latin America will be only a part of the extensive studies that IAEA is carrying out. The studies initiated under the three phases of the Agency's work programme in this field are being carried out concurrently and are expected to be completed by September 1959. The Agency will then start further specific studies, both technical and economic, in relation to selected situations. The results of these studies will be available in time for a major conference on small and medium reactors scheduled for 1960.

The findings from these studies are clearly not meant to answer all questions that may arise in the process of utilizing nuclear power in the less developed countries. Indeed, it would hardly be possible to answer all questions at the same time. It would be more realistic to tackle the problem piecemeal, ensuring, however, that one step leads to another in a logical sequence of development. The studies initiated by the Agency constitute the first major step in that direction, and their outcome will help in outlining the kind of initial practical action that will be needed.

SURVEY IN SOUTH-EAST ASIA

Technical assistance to atomic energy projects in different countries, particularly the less developed ones, is one of IAEA's principal functions. Before such assistance can be fruitfully rendered, the Agency has to study the needs and possibilities of development in these countries and decide on the lines of effective aid. Many countries have asked the Agency to assist them in evaluating their needs and conditions relating to atomic energy, to advise them on the best methods of advance and to determine how the Agency can be of assistance. Apart from direct benefit to the countries concerned, such an approach makes for better co-ordination of the Agency's activities and better utilization of its resources.

To this end, IAEA has already sent some preliminary missions to different areas and more are expected to be sent out in the future. One such mission has just completed a survey in China (Taiwan), Japan, the Republic of Korea, the Philippines and Viet-Nam, and another is visiting Argentina, Brazil and Venezuela this summer.

Earlier this year, an Agency mission visited four countries in South East Asia: Burma, Ceylon, Indonesia and Thailand. It consisted of eight members, four of whom were experts made available by Member States for this purpose,* while the others were chosen from the Agency's own staff. The work of the mission is recorded in extensive individual reports and in various notes and documents collected by the mission. These will be of value not only to the Agency and the countries concerned but to all interested in the utilization of nuclear energy for the peaceful progress of the less developed areas of the world. A brief, and necessarily incomplete, summary of the main observations and conclusions is contained in the following paragraphs.

In each of the four countries, the mission held detailed discussions with scientists and officials, collected information and exchanged ideas. Besides general discussion, consultations were held in small working groups on specific topics and problems. The members of the mission also visited atomic energy centres, other scientific and technical organizations, educational institutions as well as sites of actual or possible projects.

The reports of the mission can be considered under three broad heads. They contain, in the first place, a general description of the atomic energy programmes of the four countries, covering both current and planned activities. Under the second head can be considered the mission's comments and recommendations. Thirdly, the reports contain lists of specific requests for Agency assistance made by these countries after discussions with the mission.

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* *They were:*

Hugh Belcher (UK) Expert on the medical uses of radioisotopes; Head of the Radioisotope Laboratory of the Post-Graduate School at the Hammersmith Hospital, London;

Georges Bigotte (France) Specialist in geology and geological engineering; holds a senior position in the French Atomic Energy Commission;

Maheshwar Dayal (India) Design Engineer at the Indian Atomic Energy Establishment at Trombay;

Oleg Kazatschkovsky (USSR) Expert on the physics of experimental power reactors; worked at the first USSR atomic power station.

The mission was led by Dr. Vladimir Grigorieff of IAEA's Division of Exchange and Training of Scientists and Experts.

Outline of Activities

Atomic energy work in Burma is primarily the responsibility of the Union of Burma Atomic Energy Centre (UBAEC). Set up in 1955, the Centre is a part of the Union of Burma Applied Research Institute (UBARI). The latter is closely associated with the University of Rangoon and other interested groups. The programme of UBAEC includes a broad training scheme, the setting up of a Nuclear Radiation Laboratory by 1960-61, a study of the possibilities of installing a research reactor by 1962-63 and the possible erection of other reactors at a later date. The mission was impressed by the quality of leadership of the staff of UBAEC and UBARI and thought that the planning, construction and first operational stages of the Nuclear Radiation Laboratory were well conceived and would be successfully carried out. The mission discussed with the Burmese authorities their tentative plans for atomic energy legislation and the advice given might help in the early establishment of an independent atomic energy commission.

Ceylon too is embarking on several atomic energy activities and long-range plans are being developed. The emphasis, it is expected, will be mainly on education, raw material prospecting, isotopes and nuclear power development. A Committee on Atomic Energy was created in 1958 by Ceylon's National Planning Council, and the Committee is now working towards the early formation of a central atomic energy authority. The IAEA mission advised the officials of the Committee on the framing of such legislation as is considered immediately necessary for this purpose.

A State Commission on Radioactivity and Atomic Energy was established in Indonesia in 1954. In 1958, the Commission was replaced by the Council for Atomic Energy as an advisory body to the Cabinet; an Institute of Atomic Energy is to be formed to serve as the operational arm of the Council. At present, all work in this field is centred in Bandung, Bogor, Djakarta and Jogjakarta. Training and research reactors are contemplated for both Bandung and Jogjakarta, and should serve in the near future as focal points in the gradual development of a programme of research and training. There are also plans for the use of radioisotopes in agriculture, medicine and industry.

Dr. Sudjarwo, Governor from Indonesia on IAEA Board, briefing members of the mission during their visit to Indonesia

In Thailand, a good start has already been made with a broad atomic energy programme. Work is planned or under way for training, research, the use of radioisotopes in agriculture and medicine, atomic power, raw materials and other related fields. The Thai Atomic Energy Commission for Peace, established in 1956, is charged with the promotion, development and control of all peaceful atomic energy activities in the country. The Commission made early plans to install a research reactor and has entered into a contract with the Curtiss Wright Corporation of the USA for the construction of a swimming pool reactor with a maximum output of 1 mw. The estimated period of construction is twenty-four months and the reactor is expected to become operational by 1961 or 1962. The Commission has also established a programme of training for Thai scientists, a substantial number of whom have already studied or are now studying abroad.

Isotopes in Agriculture

The mission paid particular attention to the possibilities of applying the tools of atomic energy to agriculture, which forms the major sector of economy in South-East Asian countries. The use of nuclear radiation in agricultural research or for increasing crop yields by breeding new varieties of plants is evidently one of the most effective ways in which atomic energy can bring immediate benefit to people in these countries.

Radioisotope techniques are well suited to fertilizer-plant nutrition studies in Burma, particularly using phosphorous-32; this, in the view of the mission, seems the most promising area of agricultural research to which assistance can be given by the Agency in the immediate future. The mission also thought that it would be feasible for Burma to use seed irradiation techniques for developing a short, stiff-strawed variety of Burmese rice. It obtained samples of Burmese rice and the Agency has made arrangements for their irradiation abroad; later they will be tested under local conditions in Burma.

In Ceylon, atomic energy tools have not yet been used for agricultural research, but the mission found considerable interest in introducing such applications. It felt that the training of staff to undertake such research and the co-ordination of research programmes at the Cocoanut, Rubber and Tea Research Institutes should precede the full use of nuclear radiation in agricultural research.

In Indonesia, considerable agricultural research is being carried out both at Bogor and Gadja Mada in Jogjakarta, although uses of radiation have not yet been introduced. Further plans involve the use of radioisotopes at both sites and at a centre proposed to be set up at Pasar Minggu.

The Thai authorities have been considering the setting up of a gamma irradiation field for crop research. The mission, however, was of the opinion that it would be preferable to concentrate initially on the development of the radioisotope laboratory for soil fertility and plant nutrition work at Kasetsart University, and on the expansion of the use of fellowships for training agricultural scientists.

...and in Medicine

Another important subject considered by the mission is the use of radioisotopes in medical diagnosis and therapy. In Burma, a cobalt-60 therapy unit has already been brought into operation through the Colombo Plan. The mission, however, suggested that radioisotope work should be initiated at the diagnostic level, and that therapy with unsealed radiation sources should be introduced after sufficient experience had been gained from this diagnostic work.

There are good research facilities in the laboratories of the Faculty of Medicine at the University of Ceylon, and several research groups are already using radioactive isotopes in their work. No diagnostic work with radioisotopes is done at present. Under the Colombo Plan, a cobalt-60 therapy unit is to be installed at the Maharagama Institute. The country's medical services are well developed, and provide a solid base for introducing a wide use of radioisotopes.

As for Indonesia, the mission thought that considerable preparatory work should be undertaken before any large scale development of medical radioisotope work, for diagnosis or for therapy, took place. It has recommended that support should be given to the establishment of a radioisotope therapy laboratory at the projected Cancer Institute at Djakarta and of a second laboratory and measurement clinic for diagnostic studies in the Djakarta Central Hospital.

In Thailand, the mission noted a significant disparity between the medical facilities in Bangkok and the facilities provided by rural health centres in the districts. The two medical schools in Bangkok are associated with Siriraj and Chulalongkorn Universities. They provide good facilities for research and much progress has already been made in introducing medical uses of radioisotopes, for both diagnosis and therapy. At Siriraj, an expert from the United Kingdom, provided by IAEA, has been demonstrating the use of radioisotopes in diagnosis. The mission thought that there was need for an expansion of research projects using radioisotopes, and Thai doctors should be given opportunities for further specialized training abroad. The Thai Government is planning to organize a course on radioisotope techniques during 1961.

Members of the mission examining mounted insects in the entemology laboratory of the Kasetsart Agricultural University in Thailand

Health Physics

The mission also examined how the problems of health and safety in atomic energy work were being or were proposed to be tackled. In Burma, the plans for establishing health physics facilities at UBAEC are well conceived, but the mission felt that further training in the necessary techniques was urgently needed. The setting up of a radiation protection service, covering all institutions engaged in work with radioactive materials, should also be given high priority.

In Ceylon also, there is an urgent need for regulations to protect personnel against radiation hazards in installations where radiation and radioactive materials are handled. There is a sound scheme to develop a central radiation protection service based on the Maharagama Institute, but a necessary step towards the establishment of such a service is training in health physics of members of the Institute's staff.

The Indonesian authorities have well-conceived plans for the development of the Pasar Minggu centre to provide health physics services on a national basis; this might best be undertaken with aid from IAEA and other outside sources.

A health physics programme is an essential part of the Thai Atomic Energy Commission's reactor project. The mission considered it important that an adequate health physics department should be set up and that trained staff should be available before the reactor became operational. It also recognized an urgent need for adequate regulations for the protection of personnel against radiation hazards while undertaking medical work.

Raw Materials and Power

The mission collected a great deal of data on the deposits of raw materials needed in atomic energy work. In Burma, the present programme of the Nuclear Raw Materials Division of UBAEC is directed towards looking first for rich occurrences, even if small, which would yield readily workable material without any major financial investment. Ceylon needs a thorough and comprehensive assessment of its resources of uranium - and thorium-bearing minerals. The mission felt that the utilization of the monazite deposits in Ceylon was not as promising as the possible use of the urano-thorianite deposits in the country. Indonesia, Kalimantan and Sumatra might offer interesting possibilities of prospecting for uranium, the latter also of prospecting for beryllium. The mission thought that a complete geological survey of Indonesia's resources was needed, but the launching of a programme to develop atomic raw materials should be preceded by the strenghtening of the country's scientific staff and the establishment of experimental facilities. It also noted the need for a comprehensive survey of Thailand's natural resources as a long-term programme. A limited programme of aerial prospecting is now in progress. There are also some amounts of monazite and other useful minerals in the tailings from the country's tin mines; these, however, are not being recovered now.

The mission also studied the possibilities of utilizing nuclear energy to increase the power supply in the four countries. Burma has an installed power capacity of 164 mw, corresponding to .008 kw per capita, and a consumption of 16.7 kwh per capita per year. Electrical and total energy consumption must be increased as rapidly as possible. The total reserves of conventional sources of energy are low and there is a definite need for the utilization of atomic power in the future. The immediate need, however, is not particularly great because of the presence of unexploited hydro-electric sites.

In Ceylon, the installed capacity is 94 mw; the total generation in 1958-59 is expected to be about 230 million kwh. This corresponds to .01 kw per capita of installed capacity and to about 25 kwh per capita per year of electrical energy consumed. There are no proven reserves of coal and oil and the reserves of hydro-electric power appear to be insufficient to meet Ceylon's long-term needs. Projections of likely growth of demand for power by 1970 show that it might be economically feasible to install a nuclear power station in the late 1960's. Parallel to further development of Ceylon's hydro-power potential, the mission has suggested a thorough and continuing study of the economics and technical feasibility of nuclear power development.

The total installed capacity in Indonesia is 265 mw, corresponding to .00015 kw per capita and to a consumption of 12.1 kwh per capita per year. The immediate need for nuclear power is not very urgent because of the presence of hydro-electric sites which have not yet been fully exploited and of the availability of relatively large reserves of oil, coal and gas. As, however, it seems that eventually Indonesia will have to turn to nuclear power, the mission considered it wise for the Government to pursue its long-range studies of nuclear power possibilities, especially since the cost of conventional power seems to be increasing. It is felt by some Indonesian authorities that the installation of a small nuclear power plant in a remote eastern region of the country might be feasible in the near future.

In Thailand, the total installed capacity is 142 mw (of which 76 mw is in the Bangkok area), and in 1957 the total electrical energy produced amounted to about 340 million kwh. This corresponds to an installed capacity of about .007 per capita and to an electrical energy consumption of about 17.8 kwh per capita per year. The reserves of conventional sources of energy available for the long-term needs of the country's industrialization are low, and hence there are distinct indications of the need to develop atomic power installations. In the immediate future, the Yanhee hydro-electric project, supplemented by thermal power which can be largely fuelled with indigenous lignite, will meet Thailand's power requirements. However, the north-east region of the country is in need of industrial development and is remote from the normal sources of power, making power costs relatively high.

The reports of the mission also contain considerable information on a variety of other related subjects. On all issues of interest, the members of the mission held detailed discussions with the national authorities. On the basis of these discussions, each of the four countries has formulated requests for assistance from the Agency, mainly for the provision of experts and equipment. Some of these requests have already been approved by IAEA's Board of Governors.