ANOTHER SURVEY IN LATIN AMERICA

A preliminary assistance mission of the International Atomic Energy Agency visited Chile, Colombia and Ecuador during November-December 1961*. Members of the mission also visited Argentina to acquaint themselves with atomic energy developments in that country.

This was the eighth such mission to be dispatched by the Agency at the request of Member States and the third to go to Latin America. The information collected and the studies made by such missions help in evaluating the technical assistance needs of the countries concerned and often form the basis of specific projects of assistance.

Some of the information contained in the comprehensive reports of the mission is summarized in this article.

Organization of Activities

The organization responsible for atomic energy activities in ARGENTINA is the Comisíon Nacional de Energía Atómica (CNEA), which was established by decree-law in December 1956. The CNEA is an autonomous body, responsible directly to the President of the Republic. It is administered by a Board of Directors composed of a President and five members. The funds of the Commission are derived from annual appropriations in the national budget and from income earned by the Commission from its operations and investments. In 1961, it had a budget of the equivalent of $5.5 million.

There is no national atomic energy commission in CHILE. Most of its nuclear activities are carried out in a few national universities, particularly the Universities in Santiago and Concepción, and hospitals, notably the Hospital del Salvador, Santiago, controlled by the Ministry of Public Health. Internally, matters related to atomic energy are co-ordinated by the Corporación de Fomento de la Producción de Chile (CORFO); external relations in this field are the responsibility of the Ministry of Foreign Affairs. Draft legislation for the creation of a Chilean Atomic Energy Commission has been prepared recently, and it is expected that the Commission may be established in the near future.

The organization responsible for atomic energy activities in COLOMBIA is the Instituto de Asuntos Nucleares. The Institute came into existence in October 1959, replacing the Instituto Colombiano de Asuntos Nucleares established in March 1956. The Institute is an autonomous public body, responsible directly to the President of the Republic. It is managed and administered by a Board of Directors composed of five members and an Executive Director. The Institute prepares its own annual budget and submits it to the President of the Republic for approval. In 1961, the Institute had a budget of approximately $380 000.

The body responsible for atomic energy activities in ECUADOR is the Comisión Ecuatoriana de Energía Atomíca (CEEA). Established initially in July 1958, the Commission was re-constituted in December 1961. The Commission is an autonomous public body, responsible directly to the President of the Republic. It is composed of five members, one of whom is the President and another the Vice-President, and a Secretary. Matters relating to international technical assistance and external relations in general are handled through the Ministry of Foreign Affairs. The re-constituted Commission was only a few days old at the time of the mission's visit.

Education and Training

In ARGENTINA, training in nuclear science is carried out at the Faculty of Science, the Faculty of Engineering and the Faculty of Medicine of the University of Buenos Aires. Courses are sponsored by the Argentine Atomic Energy Commission and most of them take place in the laboratories of the Commission. The most important centre for training in nuclear physics is the Institute of Physics in San Carlos de Bariloche, which is sponsored and financed by the Commission but formally attached to the University of Cuyo. An active programme of basic and applied research in nuclear science, physics, chemistry and biology is carried out at the Atomic Energy Commission, at the Faculties of Medicine, Agronomy and Veterinary Science at the University of Buenos Aires, the University of La Plata and the Institute of Physics in San Carlos de Bariloche.

The mission felt that the university facilities in CHILE were adequate for the present stage of atomic energy development in the country. At present, the Universidad de Chile, the Universidad Católica de Chile, the Universidad de Santa Maria in Valparaiso and the Universidad de Concepción, are more advanced in scientific training than the other universities and are better equipped for developing atomic energy techniques. The mission was impressed by the work carried out at the Institute of Physics and at the Radiochemical Laboratory of the Chemistry Centre of the

* *The mission was headed by Arturo E. Cairo, of the Agency's Training and Exchange Division. The other members of the team were: John Bukovac, associate professor at the Department of Horticulture, Michigan State University, USA, and five members of the IAEA Secretariat - Montague Cohen, of the Division of Isotopes, Subhas K. Dhar, of the Division of Economic and Technical Assistance, Boris Semenov, of the Division of Reactors, George W. Tait, of the Division of Health, Safety and Waste Disposal, and John C. Webb, of the Division of Technical Supplies.*

Faculty of Physical and Mathematical Sciences, University of Chile, Santiago, where courses in radiochemistry are given and active research is being carried out in several subjects of physics and radiochemistry. The mission was interested to learn of proposals for establishing a central radioisotope laboratory; this project is supported by all the universities of Chile and was regarded by the mission as a desirable development.

Training in nuclear science in COLOMBIA has started with the establishment of the Institute for Nuclear Affairs. Elementary courses have been organized for teachers in secondary schools in order to introduce the fundamentals of nuclear science at that stage. Courses in radiochemistry have been conducted with the help of a visiting professor provided by the Agency; the Institute is fairly well equipped for this purpose. Much effort has also been made to start a programme of research in radiochemistry. The Institute works in close co-operation with the universities.

Training in nuclear science in ECUADOR is given to a certain extent at the Escuela Politécnica Nacional where courses are offered in the uses of radioisotopes. The mission was impressed both with the education and research in the nuclear field organized by this institution, and was interested in the research on radioisotope applications which has been carried out since 1956. This research has been directed towards practical problems in chemistry, agriculture and medicine. As regards training in basic physics and mathematics in the universities, both the university authorities and the Commission recognize that the present training is insufficient to permit post-graduate studies in these subjects or studies of special aspects relating to nuclear energy.

Isotopes in Agriculture

In recent years, much effort has been made in ARGENTINA to overcome agricultural problems. So far as isotope applications are concerned, it is estimated that there are at present approximately ten agriculturists with training in basic radioisotope methods and two with experience in irradiation work. Studies using radioisotopes and/or irradiation facilities are in progress at the CNEA, Instituto Nacional de Tecnologia Agropecuaria (INTA), and the Agronomy Faculty, University of La Plata. Scientists at the CNEA are investigating the available phosphorus in a wide selection of Argentine soils as influenced by addition of organic matter, rate of phosphate penetration into soil, rate of absorption and distribution in plants under varying water stress, and development of a microbial technique for measurements of available soil phosphorus. Excellent facilities are also available for irradiation work, and these are offered as a service to interested agricultural personnel.

Members of the Mission at the office of the United Nations Technical Assistance Board in Santiago de Chile in discussion with members of the UN TAB staff and Dr. Harold Behrens, Head, Radiochemistry Department, University of Chile (second from right)

In recent years CHILEAN agriculture has not been able to increase productivity sufficiently to meet the demands of an increasing population and increasing per capita consumption. Consequently, imports of foodstuffs have increased. The mission felt that education is one of the more serious problems to be dealt with immediately. At present, no investigations are being conducted in the agricultural field using radiation of radioisotopic methods. In general, agricultural scientists are very enthusiastic, but with the limited number of personnel and lack of training, nuclear technology may not be able to play a significant role in the next two or three years. The demand for the immediate solution of problems which can be resolved by conventional means will further delay the adoption of tracer technology.

Low productivity, resulting from a variety of factors, presents the major problem in COLOMBIAN agriculture. There is keen interest in the potential of nuclear technology but research using radioisotopes in agriculture is limited to the National Technological Research Institute and the Department of Agricultural Chemistry, National University, Bogotá. Both laboratories are conducting studies on phosphate absorption by plants. Emphasis has been placed on the application of radioisotopes in agricultural research by the Institute for Nuclear Affairs.

Principal problems facing agricultural scientists in ECUADOR are in areas of production technology, research, reorganization and colonization. The role of nuclear technology is limited to production problems. Training in tracer technology is available at the Escuela Politécnica Nacional, Quito, and the Institute for Nuclear Energy, University of Guayaquil. No work with nuclear methods is in progress in the agronomy departments or experimental stations. However, at Escuela Politécnica Nacional, an excellent series of experiments have been conducted on the natural synthesis of pyrethrum and rotenone using carbon-14.

Isotopes in Medicine

In ARGENTINA, clinical tests using radioisotopes are carried out in the Clinicas, Ramos Mejia,

Rawson and Children's Hospitals in Buenos Aires. At the Biophysics Institute of the University of Buenos Aires radioisotopes are used in clinical research as well as in biological studies. An IAEA expert spent six weeks in Buenos Aires last year, initiating advanced clinical tests and new methods of preparing labelled compounds. The mission was gratified to find that the work begun by the expert had been not only continued but developed since his departure. The main centre for diagnostic isotope work is the Clinicas Hospital, in which a group of ten doctors is undertaking seven different types of studies. At the Ramos Mejia Hospital, work is concentrated mainly on iron metabolism and the study and treatment of various types of anaemias. In co-operation with a hospital in Mina Aguilar, in the high Andes, studies are also being undertaken on iron metabolism in people who live at very high altitudes. The group at the Rawson Hospital is working mainly on thyroid tests and also with calcium-47 under an IAEA research contract. There is a large group of patients at this hospital with cancer of the thyroid. The only radiotherapy institute which the mission visited was the Instituto Angel H. Roffo in Buenos Aires. Here there is a cobalt unit in addition to equipment for X-ray therapy. Radium and radon therapy are also undertaken.

In CHILE, radioisotopes are used at present in six hospitals, four of which are in Santiago, one in Valparaiso and one in Concepción. Of these hospitals, two possess adequate equipment and space and are carrying out a number of tests in different fields of medicine. The others are comparatively small and their work is confined mainly to thyroid tests. However, in every case expansion is envisaged. In general, the mission considered the standard of training of the doctors adequate, although many of them lack experience in carrying out the less common types of test. The hospitals appeared to be well organized and well laid out. Five hospitals expressed a desire to carry out research in the field of endemic goitre. The mission examined the proposals for a training course in the clinical use of radioactive isotopes at the Hospital del Salvador, Santiago. It thought that the proposed course is well founded and would fulfil an important need in Latin America. The mission visited the Institute of Experimental Medicine, of the University of Chile, where research on the metabolism of the central nervous system, after exposure to radiation, is being carried out with the aid of a research contract from the Agency. The mission visited several other institutes where isotopes are applied to the study of biological or physiological problems, and also one institute in which radiotherapy is carried out, i.e. the Foundation A.L. Perez, Santiago. This institute has a cobalt unit as well as apparatus for X-ray and radium therapy. Radiotherapy is also carried out in the Radium Institute in Santiago but this institute has no cobalt unit at present.

In COLOMBIA, clinical application of radioisotopes in diagnosis is being undertaken in two hospitals: the Institute of Cancer in Bogotá and the University Departmental Hospital in Cali. The work in Bogotá is carried out in a unit attached to the Cancer Hospital. The work is almost entirely in the endocrine field, i.e. tests of thyroid function, plus a number of treatments for hyperthyroidism and an occasional treatment for cancer of the thyroid. It is planned to undertake a thorough survey of the thyroid function of the population as a whole, using a technique which involves only the collection of blood samples from individuals. An investigation into the problem of anaemia, using iron-59, is also planned. At the University Departmental Hospital in Cali there is a small radioisotope laboratory in which thyroid function tests and the therapy of hyperthyroidism are carried out. In the field of radiotherapy, only one cobalt-60 teletherapy unit is in use in a hospital. This is in the Cancer Hospital, Bogotá. The standard of work is good, but further progress depends on the provision of more training and auxiliary measuring equipment and on the replacement of some of the old X-ray sets still in use. Facilities for X-ray and radium therapy also exist in eight other hospitals in various towns in Colombia but there are no plans for extending cobalt teletherapy to these places.

In ECUADOR, clinical tests using radioisotopes are undertaken at present in two cities: Quito and Guayaquil. In Quito, the work is located not in a hospital but in the Escuela Politécnica Nacional; the mission was impressed by the high standard of the work but noted a lack of space and of auxiliary services associated with a hospital. At present, no isotope equipment is located within a hospital in Quito although some limited funds are available to the Central University for the purchase of equipment for a medical isotope laboratory. In Guayaquil, medical work with radioisotopes has only recently been initiated by a doctor who is working with his own equipment. There is equipment for X-ray therapy at the Hospital Eugenio Espejo and at the Cancer Institute, both in Quito. The Cancer Institute also has some facilities for radium therapy and it is also hoped to install a cobalt unit at the Institute.

Raw Materials

ARGENTINA has made good progress in the location and development of its nuclear raw materials. In geology and prospecting of uranium, the present programme is well organized and proceeding effectively. A number of radioactive deposits have been located, on some of which mining operations have been carried out. In some of the others, the mission felt a more complete evaluation of reserves and grade of ore and forms of occurrence is necessary. The development of the Salta deposit and further evaluation of deposits in Mendoza will probably ensure the short-term requirements for uranium in Argentina. In addition, a new discovery in the Chubut region offers much promise. For longer term requirements, aerial prospecting in selected areas should give good results. In ore processing operations, the mission noted the decision to close the uranium processing plant at Malargüe, and considered it appropriate that it should be replaced by a plant for industrial scale

production. The mission was interested in tests on heap leaching of ores being done at Córdoba, in which laboratory tests have given promising results. On the metallurgical side, the mission was impressed with the research work being carried out and the quality of the staff undertaking research.

In CHILE, the mission discussed with the Instituto de Investigaciones Geológicas the work which has been done in prospecting for nuclear raw materials as well as the future plan of work in this field. Results obtained so far have not been very encouraging, and future plans are conditioned by the realization that there is little demand for new supplies of uranium in consuming countries. The mission emphasized that this situation might change and Chile should not be unprepared for meeting its own needs or availing itself of any export opportunities that might arise. It was, therefore, suggested that a search for nuclear minerals should be included in any national programme of mineral investigations in Chile. The main attention in earlier prospecting for uranium has rightly been paid to mineralized areas of the country and to the possibility of sedimentary deposits of uranium, although later work showed igneous formations to have greater promise.

Although the Instituto de Asuntos Nucleares in COLOMBIA has a raw materials section which has been active in association with the USA under bilateral arrangements in the past, it is at present not carrying out any work on prospecting for nuclear raw materials. But since Colombia is installing a research reactor and since it is envisaged that uranium will be required in Colombia in the not too distant future, the mission thought that the present time was not too soon to begin operations with a view to locating uranium and other nuclear mineral deposits. The Servicio Geológico is a vigorous and well equipped organization with the necessary facilities for mineral prospecting and it is planning a systematic mineral survey beginning next year. The mission was given to understand that the survey would include uranium and other nuclear raw materials, occurrences of which would be brought to the notice of the Instituto for further investigation. Known occurrences of thorium minerals and of beryllium bearing pegmatites will also presumably be the subject of further studies as part of this mineral exploration programme.

In ECUADOR, the mission discussed with the Dirección de Minas y Hydrocarbones the situation regarding the country's possible needs for uranium and other nuclear materials, in the event of a programme of nuclear power being initiated. Little is known of the geology and mineral potential of Ecuador, and a first essential in any mineral exploration for uranium is a geological organization which can carry out essential field mapping in order to determine areas most favourable for prospecting. The mission urged that there should be no avoidable delay in establishing a national geological organization which would provide the basic geological services, since the search for uranium and other nuclear materials must necessarily precede by some years any proposals for the introduction of nuclear power.

Power and Reactors

The electric power situation in ARGENTINA during the last 25 years has been characterized by an increase of energy consumption at the rate of approximately 6% per annum. Electric power is supplied exclusively by thermal plants in the Gran Buenos Aires-Litoral and Resistencia-Corrientes areas, but at present hydroelectric installations account for about 60% of the total installed capacity in the other main consumption areas. The general energy situation in the country is marked by an extremely rapid development of oil and natural gas resources, and it is estimated that the country will have a substantial surplus of crudes and refinery products over its own requirements during the foreseeable future. There are therefore no plans to deal with coal, and the hydroelectric capacity, too, represents only a small fraction of the total hydro potential.

The availability of rich natural resources, the anticipated increase in oil and natural gas production, and the beginning of the construction of a large hydro power station with a capacity of about 700 MW, make it rather difficult to contemplate the possibility of building a large nuclear power station in the immediate future. However, the mission felt that because of the rapid expansion of electric power demand in Argentina, the presence of highly competent staff and a broad programme of development in the reactor field, the possibility of utilizing nuclear power should be kept under review.

For its reactor research programme, Argentina has an "Argonaut"-type reactor, RA-1, which uses plate-type fuel elements produced in the country itself. Further plans of the Atomic Energy Commission of Argentina in the research reactor field are the following:

(1) construction of a research reactor, RA-2; same as RA-1 but well-type, and with much larger output;

(2) construction of a tank-type research reactor RA-3, with a capacity of about 5 MW, for the production of radioisotopes and various physical and material investigations;

(3) construction of a prototype of a reactor for heating purposes in the Antarctic;

(4) after investigation of the prototype, construction of the reactor itself (RAA-1) in the Antarctic; and

(5) design and construction of a large research reactor RA-4 (heavy water moderated and carbon dioxide cooled, with a capacity to 40-50 MW).

CHILE possesses large resources of hydro power, the potential of which is estimated at about 20 000 MW. The country has also substantial deposits of oil and coal. Despite the abundant water power resources, less than half of the installed generating capacity is hydroelectric, the larger proportion being based on steam or diesel.

From the point of view of economic developmen and energy supply, Chile can be divided into three main zones: northern, central and southern. The northern zone displays a combination of such favourable characteristics as large consumption, high load factor, a lack of hydro and natural resources and expensive transportation of coal and oil, which together justify serious consideration of the utilization of nuclear power. But this problem requires detailed investigation of all the economical and technical factors involved.

As regards the research reactor programme, the mission was informed that negotiations were under way between Chile and the USA for the provision of a swimming pool type research reactor of 1 MW capacity for the University of Chile. The mission was of the view that construction and operation of the reactor, apart from obvious scientific advantages, would greatly help in the training of local personnel.

COLOMBIA has various natural sources of energy and its reserves are reasonably large in relation to consumption. The water power potential of Colombia is estimated at some 40 000 MW and the utilization of approximately 10% of it is sufficient for the electrification developments planned up to 1970. At present, the installed capacity in the country amounts to 921 MW, of which about 55% is hydroelectric. Colombia has also substantial deposits of oil and natural gas, and the largest coal deposits in Latin America. In the research reactor field, the mission was informed that an "Argonaut"-type reactor for the Institute of Nuclear Affairs was being provided by the USA under bilateral arrangements.

ECUADOR has no rich natural resources of energy. The hydroelectric potential of the country is estimated at about 2000 MW. Proved oil reserves are also not very large, and there are no proven rich deposits of coal. The total installed capacity of power plants in Ecuador is about 100 MW. The mission felt that the lack of sufficient natural fuel resources made it possible and justified to consider the possibility of introducing atomic power. Keeping in mind the possibility of utilizing nuclear power in the future, the mission believed that it was reasonable at present to begin with the training of local specialists in this field.

Health and Safety

In ARGENTINA, central control in health and safety matters is established by law through a licensing system applicable to all users of radioisotopes. On the scientific and technical side, work in support of health and safety measures is well proportioned to the existing needs; in some areas, such as radiochemical determination of environmental hazards, the standards appear very high. Although current problems in health and safety are well in hand, implementation of a more advanced reactor programme in the foreseeable future will introduce new problems for which technical assistance might be useful. In particular, assistance will be needed in the safety assessment and commissioning of more advanced reactors.

Members of the Mission with Dr. Tulio Marulanda (third from right), Director of the Institute for Nuclear Affairs, Bogata, Columbia, on a hill overlooking Bogata

It appears likely that responsibility for health and safety measures in CHILE will in some way be channelled through the Industrial Hygiene Group of the Ministry of Health. The aim of this group is to set up a national film monitoring service and carry out inspections, safety studies and advisory visits to the laboratories and institutes using sources of radiation. The mission thought that this would be a sound and logical development. Plans also exist for a technical radiochemical centre. This unit may be expected to act as a dispensing centre for the most efficient distribution of isotopes throughout the country and by so doing provide a channel through which the government authority could regulate and license the distribution of radioisotopes. It would also provide certain facilities for the training of isotope users in the necessary safety requirements.

In COLOMBIA, a licensing system permits the Institute for Nuclear Affairs to be aware of all users of radiation sources in the country. This step, the mission thought, should be followed up by the establishment of a national film monitoring service so that the conditions of radiation safety prevailing among users of radioisotopes may be studied. Radioactive wastes are at present sufficiently limited to offer no particular problems. However, when the output of wastes increases, local conditions of geography and land utilization may provide unusual difficulties which would necessitate special research studies.

In ECUADOR, the setting up of a national atomic energy commission provides a channel through which the government's authority with regard to radiation protection may be exercised. On the other hand, it might be difficult to set up a unit within the commission to provide a complete radiation protection service throughout the country, which in any case does not seem warranted now as the present uses of radioisotopes are limited.