

A NEW SURVEY IN LATIN AMERICA

A broad survey of the prospects of atomic development in five Latin American countries - El Salvador, Guatemala, Mexico, Paraguay and Peru - was made by a team of the International Atomic Energy Agency in October-November 1960.* This was the sixth mission of its kind to be sent out by the Agency at the request of its Member States, the earlier five having visited some other Latin American States as well as a number of countries in South East Asia, the Far East, the Middle East, Africa and Southern Europe.

The purpose of these preliminary assistance missions - as they are called - is to study at first hand the atomic energy programs and plans of the countries concerned, evaluate the possible lines of further development, and determine how best the Agency can assist in this development. In all the five countries covered by the last mission, the Agency experts visited the main centers of work in the atomic and allied fields, held discussions with the national authorities, advised them on different aspects of their plans, and helped them in formulating specific requests for Agency assistance.

The information collected by the mission and its main recommendations are briefly summarized in the following sections.

Organization of Activities

In El Salvador, The Comisión Salvadoreña de Energía Nuclear was established in April 1956. Administratively, the Commission, composed of 15 members, forms part of the Ministry of Economy, but in technical matters, it functions as an autonomous body. At the time of the mission's visit, a draft legislation concerning atomic energy was before the provisional Government of El Salvador; it has subsequently been enacted.

In Guatemala, the Comisión Nacional de Energía Nuclear, composed of 14 members, was established in January 1956. It functions as an autonomous body but, for administrative purposes, is attached to the Ministry of Economy from which it receives its annual allocations. The mission was informed that a draft legislation concerning atomic energy was before the Congress of the Republic.

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The organization responsible for atomic energy matters in Mexico is the three-member Comisión Nacional de Energía Nuclear, which was established in December 1955. The Commission, an autonomous body, is an organ of the Federal Executive and is responsible directly to the President of the Republic. The funds of the Commission are provided annually in the form of a subsidy from the Federal Government. It has an annual budget of the equivalent of approximately 1.7 million US dollars.

In Paraguay, the Comisión Nacional de Energía Atómica, established in June 1958, is, for administrative purposes, a part of the Ministry of Foreign Affairs. The Commission consists of seven members of whom three, including the President, are from the National University of Asunción, three from Government departments and one from the Navy. A draft legislation concerning atomic energy was in the final stage of processing at the time of the mission's visit.

The organization responsible for atomic energy matters in Peru is the Junta de Control de Energía Atómica, which was established in November 1955. This Control Board, with a governing body of eight members, is an autonomous body responsible directly to the President of the Republic although, for budgetary purposes, it is attached to the Ministry of Development and Public Works. The mission found that a draft of an atomic energy law had been prepared for submission to the Congress of the Republic. The Control Board has an annual budget of approximately US \$160 000.

Education and Training

The developments that have taken place in El Salvador in the establishment of new and enlarged University facilities promise well for the future training of nuclear engineers and scientists; the establishment of an Institute of Physics on modern lines will provide the necessary facilities. Some thought, however, needs to be given to the rate at which these developments will proceed. It was noted that enabling legislation had been prepared but not yet passed and that an outline syllabus for the courses of the Institute of Physics had not yet been drawn up. The Institute would provide training at two levels: graduate and post-graduate. In the post-graduate scheme, it is intended to give emphasis to nuclear science subjects, but the mission pointed out that a full training in nuclear science could only be based on a sound graduate training, particularly in mathematics and physics; it thought that the strengthening

of facilities for the teaching of physics in engineering courses at the graduate level was essential for satisfactory training at the post-graduate level.

The mission had rather limited opportunities to study the organization of university courses in Guatemala, but was able to visit the Faculty of Engineering and the Faculty of Veterinary Science. From its observations and discussions with university personnel, it felt that at the present stage considerable efforts should be directed to the development of education and training in the basic scientific subjects.

The Mexican Nuclear Energy Commission has made arrangements for the training of its scientists in the techniques for the use of radioisotopes, and the courses organized for this purpose are adequate. Nevertheless, the mission thought it advisable to set up a course of a broader and more detailed nature in radiochemistry. As regards training in nuclear engineering at the National Polytechnic Institute, the mission felt that the number of students admitted every year should be carefully considered in relation to the different projects of the nuclear energy program in Mexico. A post-graduate course in radiotherapy and nuclear medicine is given at the Oncology Unit of the Mexican Institute for Social Welfare, with the collaboration of the National Nuclear Energy Commission. As far as radiation protection is concerned, it might be desirable to conduct a semi-formal program for instructing doctors who operate X-ray machines.

In Paraguay, the National Institute of Physics and Chemistry, established with the co-operation of UNESCO, is fulfilling an important objective in the teacher-training program. It will help in improving the level of both theoretical and experimental teaching of physics, chemistry and mathematics at secondary schools. At the university level, this effort will be supplemented by the establishment of the Institute of Sciences of the National University which will make it possible to improve the knowledge of the basic sciences.

In Peru, the mission visited the Universidad Nacional de Ingenieria and the Universidad de San Marcos, and saw a need for improvement in laboratory facilities, particularly in the Faculties of Physics and Chemistry. The mission noted a desire to promote the industrial uses of radioisotopes and recommended that lectures on this should be included in the syllabus of graduate courses in industrial engineering. It felt that the courses at the Instituto Superior de Energía Nuclear did not provide adequate practical training; the new laboratory being established at the Faculty of Engineering might rectify this situation.

Raw Materials

No prospecting for nuclear raw materials has so far been done in El Salvador. Since the country has no resources of fossil fuels, nuclear fuels may be required when the resources of hydroelectric and

potential geothermic energy have been fully utilized. There is a shortage of geologists and so far there has also been a shortage of university facilities for geological training. A start has been made in training geologists at the University of El Salvador; the mission thought it desirable that these facilities be extended to provide adequate training for geologists for developing mineral and energy resources. It would be an advantage if the resources of the country's Geological Institute were strengthened in terms of equipment, library and analytical facilities.

Prospecting for raw materials in Guatemala is handicapped by a lack of geologists, geophysicists and mining engineers and of facilities for training them in the University of Guatemala. The country has tried to foster a search for uranium minerals mainly by private individuals. In any future prospecting campaign, it would be an advantage if some geological guidance were given, particularly in the selection of areas for prospecting and in the control and direction of such operations. Since it is unlikely that uranium will be needed in Guatemala's domestic program for many years, any program of prospecting for raw materials should have relation to other national developments requiring geologists and mining engineers and might best be included in a general prospecting campaign for minerals.

Mexico's program of uranium prospecting is well conceived and operated; the areas for prospecting have also been well chosen. Since Mexico is not likely to require uranium for many years, it was suggested that the present operations be modified by reducing to a minimum the mining operations on known deposits and utilizing available funds for further prospecting and evaluation of new deposits. Certain favorable areas will permit the use of aerial prospecting methods and the Nuclear Energy Commission should interest itself in applying these methods in such areas. The Commission is also proposing to establish facilities for the processing of uranium ores for the production of yellow cake and of uranium metal on a pilot plant scale. It was suggested that the plant and facilities to be established for producing uranium metal on a pilot plant scale with expert assistance from IAEA should be utilized primarily for training metallurgists and developing production processes.

Although the demand for uranium and other nuclear minerals in Paraguay is not likely to assume any significance for many years, the mission was gratified to find that the recently established Department of Geology had included uranium in its general program of prospecting for minerals. This effort, while giving uranium no greater importance than other minerals in the economy of the country, will nevertheless enable a wide search for uranium to be made as part of normal regional geological surveying and prospecting. Some parts of Paraguay appear geologically favorable for uranium and will in due course receive attention in this regional surveying and prospecting program. The mission also thought that the occurrence of minerals of nuclear interest

other than uranium should not be overlooked. Acid pegmatites are known to occur and in some of them beryl has been located. If beryllium minerals are found in abundance, their exploitation could provide a valuable export commodity, apart from meeting Paraguay's own needs for the mineral at a future date.

Peru has been engaged for many years in a systematic search for uranium. Many favorable indications of radioactivity have been located, particularly in the region of Vilcabamba, but no positive reserves of uranium ore have yet been established. Since the coastal and Sierra regions have already been extensively searched, it may be necessary now to carry out prospecting in the more difficult jungle regions to the east of the Sierras, and this may have good chances of success. The Radioactive Raw Materials Control Department is well equipped and adequately staffed. The facilities for uranium analysis are adequate as regards radiometric methods, but could with advantage be strengthened in the fluorimetric and chemical analysis sections.

Power and Reactors

The estimated cost of the power generated in the existing plants in El Salvador is relatively high, probably because the plants are small in size. The cost of power generated in nuclear plants of similar size would, however, be even higher. Nevertheless, the mission felt that it would be useful to keep the relative power costs under constant study. In this respect, the present efforts of the Comisión Ejecutiva Hidroeléctrica de Lempa to keep itself informed of developments in the field of nuclear power plants were considered adequate.

The hydroelectric resources of Guatemala are believed to be sufficient to cover the needs of the country for at least 25 years. It appears that the power produced by conventional methods is economic and no immediate application of nuclear energy for the production of electricity is foreseen. However, the mission thought it would be desirable to have a group of engineers and physicists capable of re-evaluating the nuclear power possibilities in order to make technical recommendations. The mission considered, in particular, the case of the El Petén region, which is an extensive, largely underdeveloped, forest area. The present high costs of conventional fuels in El Petén have suggested the possibility of using nuclear power under a development program now under consideration for this region. The mission, however, felt that a comparative study of conventional and nuclear power costs would be premature at this time in the absence of figures regarding the capacity of the plants to be installed, the increase of power demand to be expected, or the actual costs of conventional power in the region at different stages of its industrialization.

In Mexico, the Nuclear Energy Commission has made a survey of the country's energy resources, which are considered sufficient to meet power re-

quirements into the 1970s. The Mission thought that the Commission should continue studies of nuclear and conventional power costs. The Commission is considering a reactor program, including the installation of a sub-critical facility, a research reactor and a nuclear technology laboratory. The mission recommended the installation of the sub-critical facility and the research reactor but felt that any research program should be of a general nature. It also felt that construction of production plants for uranium metal or graphite for a nuclear technology laboratory might be premature at present, although it would be advisable to develop the necessary techniques for this purpose on a laboratory or experimental plant scale.

The hydroelectric resources available in Paraguay are considered adequate to satisfy the power requirements of the country for many years. These resources are conveniently located for the economic transmission of electricity to the present consumption areas, although not to the distant regions of the country, as for example, the north-west. The need for keeping abreast of developments in this field will remain, so that pertinent recommendations can be made to the Government when necessary.

Apparently, Peru has a hydroelectric potential which should be sufficient to meet an increasing demand for many years. The cost of electricity does not appear unusually high. The mission, however, felt that for a proper examination of the case for or against nuclear power, further information on the existing conditions than had been made available to it would be necessary. The mission considered specifically a hydroelectric project for the Titicaca Lake region. Under this project, the lake water would be pumped over the mountains and then utilized in a series of hydroelectric stations on the Pacific slope of the Peruvian Andes. A nuclear power plant is contemplated as a possibility for the initial pumping station. The mission was informed that a preliminary economic study of the thermal and nuclear possibilities was being made by an industrial concern and accordingly suggested that further evaluation should await the results of this study. Although the mission was not informed of any official plans for the installation of research reactors in Peru, the possibility of building an Argonaut reactor or a sub-critical facility was discussed. It felt it might be premature to install any reactor or sub-critical facility at the present time, but in order to give the Government adequate technical advice on the rapidly changing situation regarding nuclear power, the Control Board should try to keep a high professional standard in its reactor department.

Isotopes in Agriculture

Although isotopes or radiation methods have not yet been applied to agriculture in El Salvador, research in certain fields has reached a stage at which useful applications may soon be possible. In soil science, isotopic methods could be used in studying

the effect of various cultivations and fertilizer treatments on the root development and nutrient uptake of the coffee plant and the influence of different agricultural practices on soil moisture. They could also be used in entomology, a field in which much work has been done at the Central Agricultural Research Station; insecticides are widely used by farmers in the country.

So far, the only agricultural application of atomic energy in Guatemala has been the use of samples of coffee beans and wheat and rice seeds for irradiation at Brookhaven. The resulting coffee plants are still being studied but the wheat and rice seeds have not led to any fruitful development. Possibilities for the application of nuclear methods may arise in a few years, and the range of problems to which such methods could be applied would depend on the general training and competence of agricultural scientists. An important task, therefore, is to raise the level of this training, particularly because the number of qualified scientists is small in relation to the importance of agriculture in the country. Soil fertility and entomology are two main fields in which isotope and radiation techniques can be fruitfully employed within the next 10 years.

Mexico has a large number of agricultural scientists with a good background training and considerable practical experience, but the possibilities of using isotope techniques have not yet received much attention. The training courses organized by the Nuclear Energy Commission are serving a very useful purpose by introducing these techniques; it would be useful if the Commission were soon able to develop a more specialized course on the agricultural applications of atomic energy. Among the problems to which isotopic techniques can be applied at this stage are study of insect populations, insect pest control, measurement of soil moisture, and studies on fertilizer problems.

Paraguay has recently started making a scientific study of its agricultural problems, the attention being directed at present to general surveys and to the urgent practical problems that they reveal. Possibly, isotopes will find their first application in the study of soils, whose productivity in the main food-growing areas has been seriously lowered by over-cropping. Fertilizers will have to be used in much greater quantities, and it might be useful to apply isotopes in soil and plant nutrition investigations. In view of the importance of agriculture in the country's economy, all possible support should be given to the training of research staff and development of research work.

In Peru, isotope techniques could be used in studying the migration of cotton and potato pests. The general training and competence of the country's agricultural scientists will determine the extent of isotope applications to agricultural problems. In this connection, the mission noted that the Control Board had organized an annual post-graduate course for agricultural and veterinary science students.

Medical Applications

In the medical field, radioisotopes have been used in El Salvador both in therapy with sealed sources and in diagnosis and therapy with unsealed sources. A kilocurie cobalt 60 teletherapy machine in a Government hospital has been in operation since early 1959. A great need is felt for additional technical assistance, particularly in the physics of dose planning. Diagnostic and therapeutic applications of unsealed radioisotopes have been made by two physicians in a small laboratory at a Government hospital and at a private clinic, mainly in thyroid diagnosis and therapy with radioiodine and in a few cases of intracavitary therapy with radioactive gold. Radiation protection procedures of a rudimentary nature are now in effect in the hospital X-ray departments; no comprehensive program of education, regulation and monitoring has yet been formulated for the country as a whole.

Isotopes have been in use for several years in Guatemala, in diagnostic and therapeutic applications with unsealed sources, and in therapeutic applications with sealed sources. Some preliminary research applications have also been made. The clinical use of unsealed sources has been largely in thyroid diagnosis and therapy, but has also included some studies on fat absorption and vitamin B12 and some cases of treatment with radioactive gold. These applications have been conducted in two or three private clinics. Equipment has just been acquired at a new Government hospital which will allow numerous isotope applications to be made there. Sealed radioisotopes in the form of radium and cobalt 60 needles and, more recently, a privately owned cobalt 60 teletherapy unit have been used in radiation therapy. Radiation protection procedures are not yet well developed, but considerable interest was shown in improving this situation.

Radioisotopes are already finding fairly extensive use in Mexico in teletherapy radiation units, in clinical diagnostic and therapeutic applications of unsealed sources, and in tracer applications in research. For teletherapy purposes 17 cobalt-60 units are now in operation. This gives a ratio of teletherapy units to cancer cases comparable with that found in the medically most advanced countries. There is, however, an insufficient number of physicists and experienced radiologists. A training program for radiologists has already been instituted to improve this situation. Unsealed radioisotopes for diagnosis and therapy are used in over 30 clinical radioisotope laboratories, most of which are small and many of which are in private clinics. However, several of the larger units in hospitals are well equipped for all the common clinical isotope applications. Isotope consumption is now large enough to justify the establishment of a central laboratory to import isotopes in bulk and distribute them in smaller units to local users. So far as radiation protection is concerned, an effective start has been made under the auspices of the Nuclear Energy Commission. Formal instruction in radiation hazards has been given as part

of the radioisotope training courses and an advanced radiotherapy course. Informal education is accompanying the introduction of monitoring procedures. Monitoring activities include a film badge service, a haematological program, a radiation standards laboratory, a radioactive wastes laboratory and a program for observing environmental radioactivity.

In Paraguay, radioisotopes have been used for medical purposes under a program initiated with the assistance of the Brazilian Nuclear Energy Commission which sponsored an isotope course in Asunción in 1959 as a joint undertaking of the Universities of Asunción and São Paulo. At the conclusion of this course, equipment for a small isotope laboratory was donated to the Faculty of Medicine of the University of Asunción by the Brazilian Nuclear Energy Commission. The isotope applications so far have been almost entirely in thyroid diagnosis and a few cases of treatment. The mission was informed that the cost of isotopes set a limit to the amount of work that could be undertaken. It recommended that the National Atomic Energy Commission should explore the economics of importing isotopes from consumers of large quantities in neighboring countries.

Radioisotopes have been rather extensively used for two to three years in Peru in therapy with sealed sources, and in diagnosis, therapy, and research with unsealed sources. At present these activities are confined to Lima, although considerable isotope equipment is available at the medical school in Arequipa. A large cobalt teletherapy unit has been in operation in a hospital since 1958 with a very heavy patient load. Clinical applications of unsealed isotopes are currently conducted in at least four hospitals. These applications are largely thyroid diagnosis and therapy, but they also include several other routine clinical tests and therapeutic applications. Further, a start has been made in research applications of isotopes; at the medical school radio-carbon has been used in biochemical investigations, and in the Institute of Andean Biology studies have been made of the effect of altitude on red blood cell and thyroid status. Interest was expressed in the study of endemic goiter and endemic cretinism with radioiodine and other methods. It was felt that such a study would stimulate the introduction of preventive measures against goiter and add significantly to the understanding of endemic cretinism.

CO-OPERATION WITH REGIONAL ORGANIZATIONS

During the last part of 1960, the IAEA concluded formal agreements for co-operation with two regional organizations concerned with the peaceful uses of atomic energy. The organizations are the European Nuclear Energy Agency (ENEA) and the Inter-American Nuclear Energy Commission (IANEC). While the main activities of both these organizations differ in many respects from those of the IAEA, there are also many matters of common concern.

The European Nuclear Energy Agency was established by a decision of the Council of the Organization of European Economic Co-operation (OEEC) on 17 December 1957, and has the same 18 members as OEEC. All of these, except Ireland, are also members of IAEA.

IAEA and ENEA have mutual interests in several of the fields in which the latter has been active. These include several aspects of health and safety work, research on food irradiation, training courses, third party liability, safeguards, and nuclear power economics. Perhaps most significant of ENEA's activities have been its promotion of three joint research and development enterprises. These are: the European Company for the Chemical Processing of

Irradiated Fuels, which is building a reprocessing plant in Belgium; the HALDEN project, under which an experimental boiling water reactor is operated in Norway; and the DRAGON project, an experimental high-temperature, gas-cooled reactor to be built and operated in the United Kingdom.

Because of these mutual interests the IAEA and ENEA Secretariats began early to maintain informal contacts on a working level, to exchange information and documents, and to send representatives to each other's meetings and conferences.

Agreement with ENEA

In March 1960 ENEA suggested to IAEA that a formal agreement be negotiated to widen and formalize this co-operation. IAEA's Board of Governors approved this proposal, and in June 1960 also passed favorably upon the text of the proposed agreement. It became effective in September 1960 on its approval by the IAEA's General Conference and by the Council of OEEC. Under the terms of the agreement, IAEA and ENEA "will act in close co-operation with each other and will consult each other regularly in regard to matters of common interest". Among the types of