ATOMIC PROSPECTS IN FIVE COUNTRIES

The fourth preliminary assistance mission of the International Atomic Energy Agency visited Afghanistan, Iran Iraq, Turkey and Yugoslavia during October-November last year to study at first hand the possible lines of atomic energy development in these five countries. * It collected and examined all relevant data, held extensive discussions, particularly in the context of current plans and projects, and indicated to the national authorities as well as to the Agency the best means and forms of Agency assistance in this development.

The mission's findings are contained in detailed reports which will serve as a broad guide to the Agency's programme of assistance to these countries.

Organization of Work

In Afghanistan, there is at present no specialized body to organize and supervise atomic energy activities which are concentrated at the faculty of science of Kabul University. Several Ministries are interested in atomic energy applications and all related projects are expected to be included in the country's second Five-Year Plan beginning next year.

The Atomic Energy Commission of Iran, which is headed by the Prime Minister, is a policy-making body. There is no central establishment to carry out the scientific and operational activities which are entrusted to different organizations, agencies or institutes.

The Iraqi Atomic Energy Commission is also a policy-making body; its functions include the preparation of plans for atomic energy applications as well as the promotion of scientific research in general.

In Turkey, atomic energy activities are co-ordinated by a commission headed by the Prime Minister. In addition, there is an advisory board, although there is no central establishment to carry out the operational and scientific functions.

The Nuclear Energy Commission of Yugoslavia is a federal administrative body which is assisted in its work by an advisory committee of experts. The Commission directs and co-ordinates all work in the field of atomic energy.

Nuclear Training

The centre of higher education in Afghanistan is the University of Kabul and science teaching is done exclusively at its Science Faculty. About 400 students are now receiving higher education abroad on Government scholarships. Within the country, a UNESCO expert is organizing laboratory work for courses in physics. The Agency could assist by providing an expert in nuclear physics who would not only teach at the University but also help in setting up a nuclear science laboratory.

In Iran, the mission was impressed by efforts to improve the facilities at Teheran University where a considerable amount of equipment is available for basic studies. The standard of science courses is good, although the mission felt some improvement might be made in practical and experimental work. It also thought that Teheran University should immediately organize post-graduate science studies and set up groups of research workers.

While a great deal has been done in Iraq to establish university education on a sound basis, shortage of qualified staff constitutes a serious problem. The equipment at the University of Baghdad is not adequate for advanced science training, but the Government intends to remedy the situation so that essential training in nuclear science can be given within the country.

In Turkey, experiments in atomic physics are well organized at the University of Ankara but there is need for more advanced training in nuclear physics as well as in some of the allied subjects. Since the Middle East Technical University is in the early stages of development, the mission was not in a position to judge its potentialities. The facilities and staff at the University of Istanbul are adequate for sound fundamental training but the equipment for post-graduate nuclear science training is not sufficient. There are excellent facilities at the Technical University of Istanbul, but the mission noted certain deficiencies in the Mining Faculty.

The educational system in Yugoslavia is being reorganized. Training in nuclear science can be obtained at several specialized institutes which are well equipped and staffed. The country's extensive nuclear research programme will, however, require an even greater number of scientists and technicians than are already available. A course has been established to provide training in the use of radioisotopes.

Shortage of qualified staff appeared to be a fairly common problem. The award of the Agency's training fellowships, about which the mission has made several recommendations, will go some way towards meeting

* *The mission was led by Harold Smith, an expert in the agricultural applications of radiation and radioisotopes, who was until recently a senior member of the Agency's Division of Isotopes. The other members of the team were Arturo Cairo (training and fellowships), Munir Khan (reactors and power), Rastislav Lacko (technical assistance), Herbert Vetter (medical applications and health physics) and John Webb (raw materials), all of whom are members of the IAEA Secretariat.*

the growing demand for scientific and technical personnel.

Raw Materials

A technical mission from the French Atomic Energy Commission has started uranium prospecting in Afghanistan and has already had some success. The Agency experts felt that the problem was not particularly urgent because uranium was not likely to be put to use in the country soon; besides, communication difficulties within the country would result in high costs and reduce the chances of export. However, a geological survey, which has been established with United Nations assistance, will be valuable, not only for the training of personnel but also actual prospecting work at a later stage.

Nuclear prospecting in Iran is confined to a search for uranium. The testing of old mines and mine dumps has resulted in the discovery of radioactive ore near Anarak. Prospecting is being done with the aid of car-borne scintillometers and Geiger counters. Preparations are also being made for aerial prospecting. With the assistance of the United Nations, a geological survey organization is being set up and this should be useful in uranium prospecting. The prospects of discovering nuclear materials other than uranium are not good, although some attention might be given to the possibility of producing helium from oil wells.

In Iraq, there is not much interest at present in the search for nuclear raw materials, which is understandable in view of the country's abundant oil and hydro-electric resources. A preliminary uranium survey has, however, been made and has shown an occurrence of uranium associated with phosphate rocks. It is unlikely that the uranium could be recovered at economic cost. No other nuclear material is known to exist in Iraq, but again there may be a possibility of producing helium. Under an agreement between Iraq and the Soviet Union, Soviet experts will carry out a geological survey of the country and later prospect for minerals.

Members of the IAEA mission during their visit to Iran

Prospecting for uranium using aerial and car-borne equipment and on foot is being done in well-chosen areas in Turkey. There are good geological facilities for these operations but facilities for the analysis of ore samples and the determination of ore treatment characteristics are not adequate. Assistance in uranium prospecting is being given by the French Atomic Energy Commission. Overseas training, arranged by the Institute of Mineral Research and Exploration, will ensure a satisfactory supply of trained engineers for the work.

The search for uranium in Yugoslavia is well organized and adequately supported by geological and mining services. Operations include aerial surveys as well as prospecting with car-borne equipment and on foot. Some initial success has been achieved. Work is being done on the recovery of uranium from ores up to the pilot plant stage; research in this field is very comprehensive. Yugoslavia has no known resources of thorium, but there are some limited supplies of zirconium minerals. It might also be possible to produce beryl, and research is being done on the recovery of beryllium from ores.

Reactor Programmes

Afghanistan has no plans for the installation of a reactor in the near future. There is a great scarcity of technical manpower and it will be a considerable time before sufficient people are available to operate and utilize such a facility.

Iran has signed a contract for a 5 MW swimming pool reactor, and construction was due to start last February. The reactor is expected to be critical by late 1961 and available for research by early 1962. Under a bilateral agreement with the United States, Iran will receive US $350 000 towards the cost of the reactor. The total expenditure on the nuclear research centre that is being established will exceed US $2 500 000. The Agency mission felt that Iran needed the services of experts on reactor construction and installation and on reactor health physics.

Iraq is planning to build a research reactor near Baghdad within three to four years. Under a bilateral agreement, the Soviet Union will assist Iraq in building the reactor, training personnel, providing visiting scientists and constructing an isotope laboratory. The reactor type has not yet been decided upon. It is expected that construction will begin in 1961 and the reactor will become operational by 1963.

A 1 MW swimming pool research reactor with associated laboratories is being built at the Turkish Nuclear Centre near Istanbul and is expected to be completed by 1961. The centre will cost nearly US $3 million, and under a bilateral agreement with the United States, Turkey will receive US $350 000 for this purpose. The country is greatly in need of trained personnel and the mission felt that it could profitably use more Agency fellowships for nuclear research. It would also require the services of an expert on reactor utilization.

The first Yugoslav research reactor, a heavy water enriched uranium reactor with an output of 6-10 MW, has become critical at the Boris Kidric Institute at Vinca near Belgrade. It was supplied by the Soviet Union under a bilateral agreement, but Yugoslav scientists and engineers actively participated in its construction. There is also a critical assembly of heavy water and natural uranium at Vinca, but it was not in operation at the time of the mission's visit. Creditable nuclear research is being done at two other important institutes, namely, the Rudjer Boskovic Institute at Zagreb and the Jozef Stefan Institute at Ljubljana. A long-term research plan is also being made. The mission felt that the Agency could assist by awarding contracts for nuclear research, obtaining the services of Yugoslav scientists for assignments abroad and providing visiting professors for research institutes in Yugoslavia.

Isotopes in Agriculture

Agricultural research in Afghanistan, though of primary importance to the country's economy, is in an early stage of development, and the mission advised that training in the use of atomic energy tools in this field should not begin for another two years. The Agency could then assist in getting two of the country's agricultural scientists sent abroad to study radioisotope tracer methods in research on soil-plant relations.

In Iran, there are three main centres of agricultural research in the vicinity of Teheran: the Pest Control Laboratory of the Plant Protection Division of the Ministry of Agriculture, the Razi Institute for Vaccines and Serums, and the Soils Laboratory of the Irrigation Department of the Ministry of Agriculture. At the Pest Control Laboratory, the mission discussed preliminary experiments on the use of radiosiotopes to study the migration of the sene pest, and recommended that two members of the Laboratory should apply for Agency fellowships for further training in the subject. The Razi Institute proposes to extend its research activities with the aid of radioisotopes, and here again the mission suggested that it take advantage of the Agency's research fellowships.

The main centre of agricultural research in Iraq is the agricultural experimental station at Abu Ghraid. A promising field for the application of radioisotopes is the work being done at the Division of Soils and Agricultural Chemistry. The mission agreed with the Iraqi authorities that the Agency could help by providing the services of a soil chemist and some amount of equipment; the expert could initiate research using radioisotopes.

In Turkey a radioisotope laboratory with a programme of research in plant nutrition and allied subjects is to be established in the University of Ankara with technical assistance from the Agency. The mission found that the facilities for the laboratory were excellent and trained people were available to work with the expert to be provided by the Agency. At the Middle East Technical University, the mission discussed with an FAO expert a proposal for agricultural research using radioisotopes, and felt that the Agency could help by awarding a research contract. The mission also discussed the possibility of awarding a contract for research at the Science Faculty of Ankara University on the nutritive requirements of two locust pests.

In Yugoslavia the mission studied the agricultural research facilities in and around Belgrade and at Zagreb and Ljubljana. It agreed that the Agency could help by providing an expert and equipment to set up a radiobiochemical laboratory at an institute at Zemum, Belgrade. At the Biology Institute of the Veterinary Faculty of Zagreb University, research is being done on fasciolosis, a cattle and sheep disease. Radioisotopes can be used in studying the processes that cause this disease and in making experiments to find effective means for its eradication, and this work could be initiated by an expert from the Agency. At the Institute for Plant Breeding and Genetics at Zagreb, studies are being made on disease resistance in maize, wheat, barley and rye, and these could be facilitated by an Agency contract for research on disease-resistant mutations induced by ionizing radiations.

Medical Applications

Members of the Medical Faculty of Kabul University showed great interest in the use of radioactive isotopes for medical purposes, but the mission was of the view that the establishment of a radioisotope laboratory should be postponed until after the more pressing medical problems had been tackled. No deep radiotherapy equipment is available in the country, but the Government has decided to set up a radiotherapy department. The mission thought that a radiocaesium unit would be the best choice. The services of an expert in radiotherapy would be needed for a year to put the unit into operation and to train radiologists of the department.

Medical applications of unsealed radioisotopes have not yet been introduced in Iran, although many people are keenly interested. One problem is the lack of trained personnel, and here the Agency training fellowships would be of use. The proposed reactor centre could assist hospitals in their isotope work by providing services for the maintenance of electronics equipment and by establishing a central service for the import and distribution of isotopes. A small radiocobalt unit is in operation at the Cancer Hospital in Teheran, and the mission was informed that a radiocaesium unit, to be provided by the United Kingdom, would soon be installed at the Nemazi Hospital in Shiraz. The country is certainly in need of more teletherapy units, but they should not be obtained until more trained personnel are available.

A radioisotope department was set up at the Republic Hospital in Baghdad in 1957, and is now in full operation. The Agency has already awarded a research contract to this department. The Iraqi Atomic Energy Commission has set aside funds for the purchase of a radiocobalt unit, and the mission felt that this unit should also be located at the Republic Hospital. The services of an Agency expert would be useful in putting it into operation.

In Turkey, diagnostic and therapeutic work with unsealed radioisotopes is being done at the Medical Faculty of Istanbul University and in the isotope laboratories of the hospitals at Haseki and Guraba. The quality of the work is good, although the equipment is inadequate. Additional equipment is to be provided by the United Kingdom. In Ankara, it is proposed to set up a central radioisotope laboratory at the University Hospital to serve the needs of a number of departments of the Faculty of Medicine. At the time of the mission's visit, a radiocobalt unit had arrived for the Radiological Institute of Istanbul University, and the Railway Hospital there was about to order a betatron for medical purposes. In addition, three units had been requested from the US International Co-operation Administration.

There are a number of very well-planned laboratories in Yugoslavia for the medical applications of both sealed and unsealed radioisotopes. These laboratories serve as focal points for clinical isotope work in hospitals. Certain difficulties, however, are experienced in obtaining regularly spaced supplies of radioisotopes in sufficient amounts and at reasonable prices. There is a shortage of supervoltage radiotherapy equipment in the country. There is one radiocobalt unit in Zagreb, and it is planned to set up two more units, one at Belgrade and the other at Ljubljana.

Radiation Protection

The provision of safety measures is not an immediate problem in Afghanistan but it might be advisable for a physicist of the country to apply for an Agency fellowship for training in this field.

No definite plans have yet been made for radiation protection measures in Iran, but the problem needs immediate attention. It is also necessary to set up a film badge service. Here again, lack of adequately trained staff constitutes a serious problem.

In Iraq also, the mission stressed the urgency of safety and protection regulations, for which no definite plans have yet been made. Training in this field should be given high priority when applying for Agency fellowships.

Shortage of health physicists was also noticed in Turkey. An Agency expert could help in formulating safety regulations, introducing the relevant arrangements and setting up a central health physics laboratory. A film badge service has been introduced at the Radiological Institute of Istanbul University but at present it only covers the radiation personnel of this Institute.

The Yugoslav authorities have given a great deal of thought to the establishment of adequate radiation protection services throughout the country, and the basic legal requirements have been met. In addition to the regulatory work, a start has been made with research in this field. Besides, it is planned to organize a training course in health physics work at the Institute of Medical Research at Zagreb. The Agency could assist by providing visiting professors and granting training fellowships.

Power Needs

The total installed electrical capacity in Afghanistan is about 46 MW, of which 33 MW are derived from hydro power and the rest from diesel and thermal plants. The annual per capita consumption is 6 kWh. The country in general is poor in conventional power resources. It has a known hydro potential of 2 500 MW; deposits of medium quality coal amount to about 80 million tons and there are no known reserves of oil or gas. The topography makes communication a major problem. Fuel transportation costs are high and one thermal kWh costs over 60 mills in Kabul, and even more in other towns. Nuclear power could be considered to meet the demands for electricity in populated areas which are difficult to reach. The mission suggested that the possibility of utilizing nuclear energy in the future to supply power to the isolated regions of the country might be investigated. The Ministry concerned agreed to collect the necessary information about such regions and send it to the Agency for further analysis.

The present installed capacity in Iran, including the stations serving the oil industry, is 360 MW and the annual consumption per capita is 35 kWh. Iran is one of the major producers of oil with reserves of six thousand million tons. The coal deposits exceed 100 million tons and the hydro potential has been estimated at 5 000 MW. In view of the abundant resources of oil and other conventional fuels, the country is not considering the use of nuclear power in the near future.

Iraq's installed capacity in 1959, consisting of oil and gas fired thermal and diesel stations, was 250 MW, and the annual per capita consumption was 100 kWh. With the completion of the northern, central and southern power stations, which is due this year, the total capacity will increase to 435 MW. The country is very rich in fuel resources, with oil reserves of four thousand million tons and a gas production of 200 million cubic feet per year. The hydro potential, it is estimated, is at least 300 MW. In view of large and cheap conventional power resources, there is no need for commercial nuclear power in the foreseeable future.

The total installed capacity in Turkey is 1 180 MW; of which 830 MW are thermal and 350 MW hydro. The per capita consumption in 1958 was about 90 kWh. The country has a net hydro potential of 100 thousand million kWh per annum, which has so far remained largely unexploited. The thermal resources include 482 million tons of hard coal, 424 million tons of lignite, and five million tons of oil. Because of these large conventional power resources, there appears to be little indication of nuclear power being competitive in the immediate future. The country is, however, closely studying the situation in the Istanbul area.

Yugoslavia's total installed capacity at the end of 1958 was 1 860 MW, comprising 1 060 MW hydro and 800 MW thermal power. The per capita annual consumption was 404 kWh. The net hydro potential exceeds 60 thousand million kWh per annum, of which about 8 per cent has been developed so far. The coal reserves consist of 20 thousand million tons of lignite, two thousand million tons of brown coal, and 100 million tons of hard coal. The electrical power industry has grown very rapidly during the post-war period. Possessing extensive conventional resources, the country is not planning to use atomic power on a commercial scale before 1975-80. An experimental nuclear power plant is envisaged for 1970.

RADIOACTIVITY AROUND US

The growth of atomic energy has been accompanied by an understandably widespread concern over the hazards of atomic radiation. Indeed, fears have sometimes been expressed that even the development of peaceful applications may harm man's health and heredity to an extent that is incalculable at the present stage, and nothing is more potent than the dread of the unknown.

While a great deal is still unknown, enough, however, is already known to indicate that the hazards involved in the pèaceful pursuit of the atom have often been exaggerated. The nature of the possible dangers is essentially clear, and if their extent and what can be called their modes of operation and specific effects are still matters of some expert disagreement and much popular conjecture, one can assert that the hazards are not such as cannot be controlled.

That the hazards exist is not denied; nor is it claimed that they can be eliminated altogether. All atomic fuel is radioactive, and the very use of this fuel creates more radioactive material. And since ionizing radiation is potentially dangerous, the production of these new radioactive substances increases the sources of radiation to which people may be exposed, and consequently the harm that may be caused.

No human ingenuity can wipe out this radiation. But what human skill and organization can perform is to eliminate as far as possible the chances of exposure and hence the possibility of harm. Of this one can be reasonably certain: that the employment of atomic energy to promote man's peaceful progress need not be attended by an impairment of his health or genetic future, that it is possible to devise and adopt adequate measures of safety.

This task has two broad aspects: to ensure that people engaged in atomic energy activities are not exposed to excessive radiation in the course of their work and to protect the world's population in general from the radiations given off by the radioactive material produced by the atomic energy industry. The first requirement has to be met by the adoption of protective measures in all atomic energy establishments and laboratories where radioactive materials are used, and an important part of the Agency's work is devoted to the formulation of these measures. Perhaps more important - at least from the public point of view - is the work to ensure the safety of people in general. And the basic aim in that respect is to see to it that the development of atomic energy applications does not lead to an increase in the levels of radiation in man's immediate environment.

It must not be forgotten that all of us are inescapably subjected to some amount of radiation from our natural background, the chief sources being the radioactive elements on the earth's surface (e.g. uranium and thorium and their daughter products), cosmic rays and substances like radiopotassium and radiocarbon present in the body. Man has always lived with this radiation and seems to have adjusted himself to its effects. Release of new radioactive material in the environment as a result of the peaceful applications of atomic energy would certainly add to this background radiation, and it is generally believed that a substantial increase in the levels of general radiation may upset the delicate balance between man and his environment. The precise extent of the increase that is likely to be harmful may still be debatable, but the aim must be to keep it well below the threshold of danger.

To achieve this aim, the main effort has to be directed towards preventing the newly created radioactive material from getting into man's environment and increasing the levels of radiation. Essentially, this is a problem of safe disposal of radioactive wastes, a problem with which the Agency is actively concerned. Aspects of it were discussed in detail at a conference in Monaco last November, and the exchange of ideas and information that took place there is being followed up with intensive research on methods of disposal which are both adequate and safe.

Contamination of Environment

Despite all safety precautions, however, a certain amount of radioactive material is likely to be released into our environment. That itself need not be a cause for concern because if the precautions are adequate the nature and amount of the radioactive material that