Report from Mongolia: Nuclear energy and scientific development

An overview of co-operation between the Mongolian People's Republic and the IAEA

by Ch. Tsehrehn

The liberation of the high-density energy confined in the atomic nucleus is celebrated as the greatest achievement of science and technology of our age, and the peaceful use of that energy for social and economic development is a matter of the utmost importance to all forward-looking people. The international community has realized this, and a great deal of political will and awareness has been shown in putting the economic, scientific, and technological resources it has at its disposal into attaining this highly important and urgent objective. The IAEA plays an enormous and invaluable role in this. As an international organization of great authority called upon to combine and co-ordinate the aspirations and efforts of the world community in the peaceful utilization of nuclear energy, it has already won great confidence and respect from the international community for its very worthwhile activities.

Nuclear energy is used for peaceful purposes in power generation and elsewhere. Generating electricity from nuclear power plants entails large inputs of resources and also specialist staff with the greatest range of skills a highly industrialized country can provide; the Third World countries today are developing nuclear science and technology primarily along other lines. The information at our disposal and from the IAEA shows that more developing countries will begin building nuclear reactors in the next few years.

The IAEA Power Reactor Information System (PRIS) shows that, as of 31 December 1987, 417 reactors were in operation in 26 countries, with a total electricity output of 296 876 megawatts, providing 16% of the electricity generated worldwide. Some countries are obtaining 50-70% of their electricity from nuclear power. The good economics, long lives, and relatively high degree of ecological safety of nuclear power plants make them promising sources of electricity, and life without a further increase in the nuclear input to the world energy balance can scarcely be imagined. Even so, nuclear power is the power generation industry's youngest offspring, for all its technological complexity in operation. The history of its development alone is enough to show that critical situations have indeed occurred in which human life and the environment were threatened.

The IAEA, in accordance with its obligations to Members under its Statute, does all possible to ensure safety and to prevent accidents like those which happened at Three Mile Island in the USA and Chernobyl in the USSR. One of the measures taken was the creation of the OSART (Operational Safety Review Team) programme to check safety at operating nuclear plants and to make available details about experience gained in safely operating nuclear power reactors.

Groups such as OSART, composed of IAEA experts and scientists from its Member States, have given convincing proof that they are both necessary and useful and must be set up in the closest possible co-operation with IAEA Members. The IAEA's activities in co-ordinating Member States' joint efforts in the peaceful utilization of nuclear power, and what it has achieved by doing so, favour the optimistic view of the future of power generation as a whole throughout the world; we can expect that in the next few decades, alongside fission reactors, we will see the introduction of thermonuclear reactors where the energy comes from the fusion of light nuclei. It will be a whole new sphere of human endeavour, in terms of power generation, and it will require a whole new approach to the problem of ensuring safety. The most important thing, in our view, is that the leading countries in this field should co-operate on scientific research and experimental design work. There is reason to hope that the International Thermonuclear Experimental Reactor (ITER) project will be both a source and a gauge of fruitful international co-operation in the future.*

Academician Tsehrehn is Deputy Chairman of the Nuclear Energy Committee of the Council of Ministers of the Mongolian People's Republic.

* The ITER project, under IAEA auspices, involves the European Community, Japan, USA, and USSR.

The development of nuclear power goes hand-in-hand with another problem of no small importance. It can best be explained by saying that the siting of nuclear power plants is dictated more by the geographical distribution of a country's productive capacity than by ecological considerations. In other terms, this means that radioactive material is being redistributed and the new distribution is very different from the one which formed over the geological history of the Earth; experience tells us that the trend has recently become ever more pronounced. That trend gives rise to the vital and urgent necessity for more thorough and continuing research into the possible after-effects of this redistribution of radioactivity as part of wide-ranging international co-operation to prevent undesirable effects from the interaction between concentrations of radioactive material and the ecosystem, both locally and on the planetary scale.

Mongolia, which has been a Member State of IAEA since 1973, takes part in almost everything the Agency does concerning the peaceful utilization of nuclear energy, with the exception of using it to generate power; no nuclear reactors or power plants are envisaged in Mongolia's plans for future economic development. However, given the importance of the obligations in the conventions adopted at the Special Session of the General Conference of the IAEA in 1986, Mongolia considered that it was necessary for it to participate by mobilizing all the means at its disposal to organize assistance to other countries in the event of an accident at a nuclear facility giving rise to a radiation danger. It therefore decided to accede to those two very important international conventions: the *Convention on Early Notification of a Nuclear Accident* and the *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.*

Nuclear applications

Mongolia is today co-operating with IAEA in the field of nuclear energy applications by introducing accurate research methods into various branches of its economy in order to increase efficiency and by providing training to qualify the personnel it needs in nuclear science and technology. It is also using the achievements of nuclear physics in applied research. These kinds of co-operation are providing their own justification in practice. A nuclear research laboratory has been set up, attached to the Mongolian State University, and is equipped with a neutron generator, an isotope neutron source, and X-ray fluorescence analysis spectrometer, other measuring facilities and semiconductor detectors, and a desk-top computer. Research is being conducted there on developing rapid analytical methods for samples of copper and molybdenum ores from the Ehrdehneht beds and of feldspar and other useful minerals from various Mongolian deposits. This has made it possible to use nuclear techniques to provide significant cuts in assay time and increases in analytical quality, and has been of great benefit to the economy.

The other, no less important, aspect of the laboratory's activities consists of training professional staff to qualify them in nuclear techniques and applications.

The Institute of Physics and Technology of the Mongolian Academy of Sciences has received important — by reason of their purpose — items of scientific equipment. These are in use today for research into the nature of molecular interactions in bioactive substances, which are observed using electron paramagnetic resonance. The biophysics sector of the Institute is carrying out contract research work for other scientific organizations on the physical and chemical characteristics of materials such as samples from coal deposits, mineral fertilizers, and a varied range of raw materials for industry. Important work has been done on finding more accurate ways to map and quantify Mongolia's coal fields.

It is worth noting that the achievements of science and technology, including nuclear physics, must be more effectively introduced if there is to be intensive development of agriculture, geological prospecting work, the mining and ore industry, and other social and economic areas in the life of the country. The Agency's technical assistance has been of paramount importance in meeting this need; it is important, indeed, for all Members, and not just for Mongolia. We therefore attach great importance to the visits made to our country by the Directors General of the Agency — by Dr Sigvard Eklund in 1976 and by Dr Hans Blix in 1986 — and to their many meetings with the leaders of our country and with other officials. The result has been that a real opening has been made towards expanding working contacts with the Agency and promoting the more efficient and effective development of co-operation between Mongolia and the Agency. Clear proof that this is so is the fact that a range of scientific activities, of great importance for Mongolia, have been carried out along Agency lines over the past 3 to 4 years. Under Agency projects, technical assistance worth more than US $950 000 has been received for equipment up to the end of 1986 by Mongolian organizations, 15 Agency experts have come and spent a total of 4.5 man-years, and 12 specialist staff have been sent on long-term study trips with Agency fellowships. These projects are used to develop the scientific research and teaching base in scientific organizations and institutions of higher education, in medical diagnostics, to obtain new mutant strains of crop plants, for dosimetry services, and for environmental monitoring.

Equipment and facilities worth US $430 000 have been received for a project entitled "Application of Nuclear Technology", which has now lasted over 10 years. The project involves training nuclear physics specialists; developing neutron activation, X-ray fluorescence, and atomic absorption methods for elemental analysis of minerals, ores, ore concentration industry products, soils, plants, and other biological objects; and for developing nuclear electronics and microprocessor techniques for training and production purposes.

The assay methods that have been developed are widely used for area research throughout the Khubsugul'skij and Selenginskij regions to determine the elemental composition of their soils and vegetation and for analysing process samples containing copper, molybdenum, and associated elements from the Ehrdehneht mining and ore enrichment combine. The results are used both to determine the export values of the copper concentrates and to certify a range of standard samples, including copper and molybdenum concentrates, phosphorites, fluorites, rocks, and soils.

Technical assistance is the basis for development work by our scientific staff on two variants of a facility to carry out rapid determinations of the fluoride content of ores and concentrates, to be used by the mining industry. They are also developing a neutron irradiation method for determining the protein content of wheat using a low-power neutron source. The technical assistance for this project has resulted in a laboratory which is itself a sound basis for training young students, who are specializing in nuclear physics, nuclear electronics, and computer technology, and for training more highly qualified scientists in neutron activation and X-ray fluorescence analysis and in isotope and nuclear radiation applications in various sectors of the economy. In the past 3 years alone, 74 people working on isotope and nuclear radiation applications in geology, medicine, and industry have completed training courses; this makes it possible to introduce the achievements of nuclear physics in wide areas of the economy.

Another Agency project entitled "Radioimmunology Laboratory" has been successfully underway since 1983, and isotope diagnostics for chronic diseases of the kidney, liver, pancreas, and thyroid have been in use since 1975. The establishment of the radioimmunology laboratory with Agency technical assistance has taken isotope diagnostics a step up the ladder. It has made it possible to put a new diagnostic method, based on hormone determination, pathogen antibodies, and antigens, into medical practice. The method is used diagnostically in endocrine disorders, oncology, gynaecology, allergology, and infectious diseases; it is also used to monitor therapeutic effectiveness.

Radiospectrometry has been put into practice in research into the physical and chemical characteristics of bioactive molecules with low molecular weights and the conformational dynamics of proteins. Determining the physical and chemical characteristics of plant pectin and melanin using EPR spectroscopy has practical applications in medicine. Radiospectroscopy will be widely used in the future in research into the structural alterations in proteins and the interactions between compounds of proteins and molecules of low molecular weight. Agency assistance is also being used in plant mutation breeding to select crop plants for their genetic characteristics.

Research is being conducted into the primary damage to haemoglobin nucleic acid, tomato, and wheat caused by gamma irradiation. The free-radical processes related to the effects of low and high doses of gamma irradiation on biological samples are being studied with a view to obtaining useful mutations of crop plants. In the future, modern molecular biology methods will be introduced into stock-breeding to update and improve breed selection in dairy livestock and to increase selection effectiveness and efficiency. A radioimmunoassay laboratory is planned, which will select livestock by hormone status and evaluate their overall physiological condition.

A radiation protection and dosimetry laboratory has been set up with Agency technical assistance to meet the need for up-to-date isotope and nuclear radiation methods to be applied in medicine, mineral prospecting, and other sectors of the economy. The laboratory calibrates dosimetric and radiometric instruments, monitors dose levels to personnel, workers, and the population as a whole, and also studies environmental radiation.

As part of Mongolia's co-operation with the Agency, work has been done over the past few years in training professional scientific staff by organizing national scientific courses based around the research laboratories established with Agency technical assistance. This makes it possible not only to increase the number of participants in these courses, but also to solve practical problems through participation by Agency experts. Two courses of this kind, on nuclear analytical techniques and on the use of personal computers to automate physics experiments, were held in 1985 and 1986. All in all, over 90 scientists from 13 different institutes and scientific organizations in Mongolia attended these courses, which were organized around the technical base of the Nuclear Research Laboratory of the Mongolian State University.

Even though co-operation between Mongolia and IAEA is at the very first stage of development, it, and particularly the assistance provided, is giving a noticeable boost to the development of scientific research in Mongolia in the field of nuclear science and technology for peaceful purposes. It is significantly promoting the professional development of highly trained young Mongolian staff in this extremely important branch of modern science.

Mongolia, as an IAEA Member State, has not only participated in the various activities undertaken by IAEA. It also attaches great importance to close and effective co-operation with the Agency, given Mongolia's need for more intensive development of its economy and the need to promote the peace and security of peoples throughout the world.