MAKING BETTER USE OF RESEARCH REACTORS

Some 250 research reactors are in operation in the world today, and there are problems in putting them to the most fruitful use. The difficulties - of trained manpower, of auxiliary equipment, of satisfactory research programmes, of co-ordination, between the various disciplines - are common to all users. But as is only to be expected, they press more heavily on the newly-established centres, particularly those in the developing countries which are lacking in long experience in research and usually severely limited as to technical manpower and money.

The IAEA has been turning its attention to this question for the past three or four years - ever since, in fact, its early assistance missions and other field operations brought it into close contact with the operations of numerous Member States. The task of providing assistance and advice in this matter is growing. Many centres have been building research reactors under bilateral arrangements; with the completion of their projects this form of aid usually ends, and they look to IAEA for help in operating the reactors.

Although some critics consider that difficulties have been caused by premature construction of research reactors, before well-founded programmes of nuclear research had been developed in the countries concerned, several valid motives have led to the establishment of some of these centres at an early stage.

A research reactor often provides an effective stimulant for scientific research in the country. It is a remarkably versatile tool for workers in many fields of science and technology. There have been instances where the establishment of a research reactor has had a great impact on the scientific education of a country and has led to a salutary reappraisal and reforms.

A reactor is sometimes considered to be a particularly effective means of retaining in the country men trained in the nuclear field. This particular problem is common to most countries. In fact, it is a feature of the present age that scientists in search of better facilities and wider opportunities for their work will leave their country or - in the larger and more developed countries - will move freely from one establishment to another. When such emigration takes place from a smaller country where scientific manpower is already scarce the drain can become crippling. Some of these countries regard this in itself as a compelling reason to set up a reactor or other major installation as a counter-attraction.

Looking further ahead, most countries consider that nuclear power will make an important contribution to their development at some stage. Meanwhile, a research reactor can help them to prepare the way by acquiring a basis of nuclear technology and by building up a pool of trained manpower.

Conditions for Success

Whatever the precise justifications for a research reactor, once it has been set up the country must take account of certain inescapable inferences. One is that a research reactor centre must be an integral part of the scientific work of the country. It cannot flourish in isolation, and smaller countries which have tried to make such centres self-sufficient have not always been successful. Larger countries have usually developed these centres into research institutions or national laboratories, and have found it necessary to establish close and continuing contacts with universities and other institutions of pure and applied research, and training. The techniques of atomic energy have a bearing upon most fields of science and technology - medicine, agriculture, geology, engineering, chemistry, to name but a few - and an atomic energy research centre can maintain its effectiveness only by reaching out into these fields, and by receiving from them in return a constant flow of ideas; there should be regular interchange of personnel. Close links should also be established with industry where this becomes possible.

The available scientific talent must be able to make its full contribution to the programme of the research centre without being impeded by failures of organization or of finance. Absence of permanent senior staff, lack of leadership, and diffusion of responsibility have hampered many of the new centres. If he is to give of his best, a scientist must be backed up by a group of collaborators, not only in his own special field but in supporting fields also. In addition, the research centre must be able to count on regular and sufficient budget allocations.

There have been repeated complaints from many places of equipment shortages usually attributed to lack of foreign exchange. Some countries have partly met the difficulty by making some of their instruments locally, but they still need to purchase specialized items, which can usually be secured only if the government gives the programme adequate support, supplemented if possible by some form of external assistance.

Lack of scientific manpower is a major obstacle in the work of most of the smaller laboratories. As one commentator has remarked, "There is no doubt

that these laboratories have a few highly qualified scientists in certain fields, but their number often falls short of the critical mass needed for initiating and maintaining experimental work. The lonesome specialists soon get discouraged and tend to leave or become inactive." A possible solution may lie in the pooling of talent in a region or among neighbouring countries, but to meet long-term needs a vigorous training programme is necessary.

Research Programmes

There is a tendency to expect too much too soon from a research centre - particularly on the part of administrators, who are ever anxious to see expenditure justified by tangible results. They are apt to regard a research reactor as a machine which will automatically yield research results without further investment, and to expect scientists to begin likewise to show immediate results, forgetting that it may be years before a laboratory can become fully productive. This applies especially in countries where research reactors have been installed without adequate preparatory work. In countries having a long-established tradition of research it may not be so difficult to develop satisfactory research programmes. If a broad programme of nuclear research already exists in a country a research reactor is merely an additional tool which can be put to work without delay.

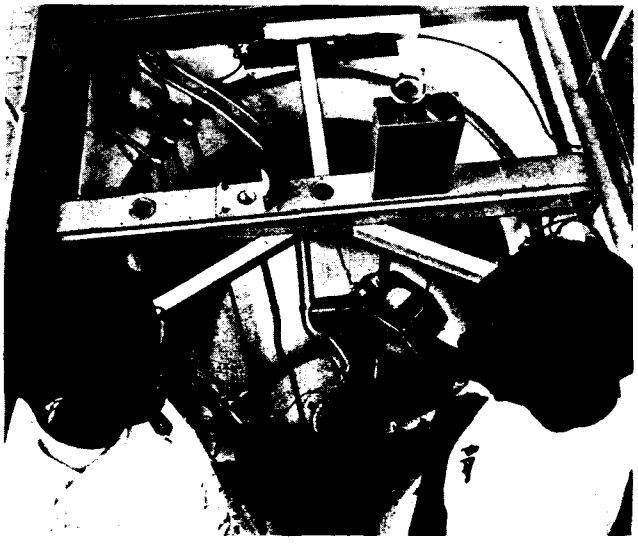
Where there is no prior nuclear research experience, there is considerable difficulty in evolving suitable utilization research programmes. It is simple to import a reactor, but not possible to import a blueprint of a programme from one laboratory and to make it work in another. The research plan suitable for a particular laboratory must be evolved gradually in the light of local needs, circumstances and resources.

In the initial stages, new centres need to devote particular attention to training; later they must work out a programme which maintains a just balance between pure and applied research. Both have their purpose. Pure research is favoured by scientists because it satisfies their natural sense of inquiry and can gain recognition for them in the scientific world. It also helps build up scientific traditions and knowledge of basic techniques. Applied research on the other hand can lead to tangible results of practical importance. Hence many new centres are especially interested in such fields as agriculture, biology and medicine.

Most of the new centres possess only low-power reactors. Given sufficient manpower, money, and freedom of choice, they would still have trouble in carrying out original research, because the number and type of problems which can be investigated are limited. There are a relatively large number of competitors for the limited number of problems which can be handled, and in addition there are many high-power reactors in advanced and more fully equipped centres which tackle the most interesting problems, leaving the more tedious and laborious ones for others.

It is necessary to face these difficulties in order to achieve the best results. They are indeed numerous and quite serious, but they should not be allowed to cause undue discouragement. Many possibilities remain for original research with low-power reactors, and with good planning and, above all, good collaboration between neighbouring countries, the new centres can accomplish much.

Professor Felix Malon and L. Sawolona, by a research reactor at the Trico centre, in Leopoldville. The centre has been awarded on IAEA contract to study bone conditions caused by leprosy, smallpox and other diseases and by nutritional deficiencies. (Photo. United Nations)



It is here that the role of the IAEA becomes important. The Agency's 1961 General Conference resolved that steps should be considered "to promote international co-operation in order to ensure full and effective utilization of the research reactors in such Member States as may require assistance towards that end". The same subject forms an important item in the long-term programme for the Agency's activities which was adopted by the last General Conference in October 1963.

In this programme, planning starts from the premise, firstly, that the simplest type of research reactor is expensive to build and to operate, and the fullest possible use ought therefore to be made of it; secondly, that research reactors properly and intensively used not only yield valuable scientific information, but also contribute to the development of national nuclear power programmes.

Agency Plan

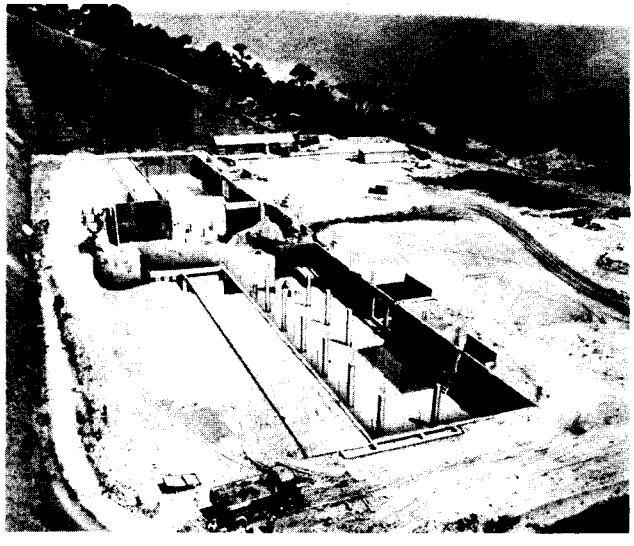
The long-term plan recognizes that the Agency could render valuable service in encouraging the best possible use of research reactors, in helping to co-ordinate programmes of Member States and promoting the exchange of information on results obtained. It will therefore prepare to meet an increasing number of requests for such assistance, and try to meet these requests wherever possible with an integrated programme covering a long period and as many subjects as possible.

To this end, the Agency intends to keep in close touch with certain relevant subjects, such as nuclear physics (particularly in respect of the use of research reactors of small and medium power), physics of condensed state, reactor physics and technology, radiation chemistry and radiochemistry including radioisotope production techniques, and methods of activation analysis, radiobiological and medical studies, and problems of reactor operation.

To assist newly-established centres, the Agency encourages co-operation and co-ordination between them, and also with centres in older and more advanced countries. To this end regional study groups and the convening of panels of experts are important to the plan, as are also Agency encouragement for joint research ventures, co-ordination of research and exchange of scientists and information.

Since the award of research contracts can make an effective contribution to the programmes of a research reactor, the Agency expects to assign for that purpose a bigger proportion of its appropriation for research contracts.

Venezuela's first research reactor was set up in mountain country near Caracas. Six years ago the foundations were built for this swimming-pool type reactor, installed for the Venezuelan Institute for Neurology and Brain Research. (Photo. US Information Service)



In addition to the foregoing matters which the Agency is prepared to initiate under the long-range plan, it will provide a variety of assistance on request. Where small amounts of special materials and equipment are wanted for research, simplified procedures will be applied in order to speed up deliveries. Where experts are requested, instead of sending one expert for a long period, it may prove better in developing a research programme to send a scientist for short periods at longer intervals as the programme reaches the stage of independent work. Alternatively, the use of regional experts and close inter-laboratory collaboration could achieve the same purpose.

If several young scientists from the same laboratory are awarded fellowships to study closely related aspects of one subject, it would have a better chance of developing into an independent programme. This method would also help to obviate a sense of isolation which often affects scientists when they cannot exchange ideas with fellow-workers in the same branch of science. Where research centres need help in formulating their research programme or a specific part of it, the Agency will be prepared to send expert missions for the purpose.

The long-range plan outlined above provides a definition of policy and envisages an expansion of activities, but many of the matters enumerated have already been taken in hand.

Series of Conferences

It is two and a half years since the first Agency conference on the programming and utilization of research reactors was held in Vienna in October 1961. Two hundred scientists from 35 countries, as well as from international organizations, attended the meeting. As was appropriate at this initial gathering, scientists from the more advanced countries gave the lead by discussing the experience gained, problems of organization and training, useful fields of research with reactors, the kinds of research reactors and their uses, possibilities of radioisotope production, and the scope for international collaboration. This conference mapped out the field and incidentally produced a number of suggestions of ways in which the IAEA could assist, particularly by promoting bilateral or multilateral arrangements between new centres, so that they might profit mutually from work in progress.

During this symposium the holding of smaller regional meetings in the field was suggested; such so-called "study group" meetings could be suited in size and form to the needs and interests of the centres in the region.

The next step was the convening of a study group in Bangkok in December 1962, to consider utilization of research reactors in Asia. Fifteen coun-

tries were represented; most of the participants were from Asian countries, but a few prominent experts from elsewhere gave the meeting the benefit of their experience and knowledge. This is a pattern which has been followed in subsequent regional meetings, which are normally attended by one or two specialists from outside the area.

The Bangkok meeting concerned itself not so much with purely scientific matters as with the various questions of policy, organization, finance, manpower and equipment, which must be answered as a preliminary to research work. It also discussed a number of practical problems incidental to reactor operation, such as organization of staff, the composition of safety committees, power and water supplies, and also production of radioisotopes. An account of this meeting was given in the IAEA Bulletin of April 1963. One of its conclusions was that further meetings ought to be held to consider the more specific problems.

In 1963, therefore, three more regional meetings were organized - at Athens, from 9 to 13 September, at São Paulo from 4 to 8 November, and at Manila from 9 to 13 December. Although the three meetings varied in scope and approach they revealed important areas of common ground. All three produced evidence especially of a strong mutual desire among scientists of the regions concerned for closer contacts and systematic exchanges of information.

At Athens there were about 80 participants from 17 countries and one international organization. Five advanced countries of Europe and North America sent experts. It was the first meeting of its kind in the area, and was very useful if only in bringing together responsible scientists. Hopes were expressed that these contacts would pave the way for definite arrangements between laboratories, in which the Agency might assist.

In contrast to the Bangkok meeting, several of the countries involved have been conducting advanced research already, while most of the others have completed the initial stages of planning programmes and building installations. In consequence, lack of equipment did not figure as a topic for discussion, but there was emphasis on lack of manpower required to carry out the programmes in hand, and a strong interest in the possibility of pooling manpower as between different centres. Considerable attention was also paid to possible Agency advisory functions, in respect of standardization of radioisotopes, for example, and of reactor safety criteria.

The meeting brought up a number of suggestions, including establishment of an IAEA research centre, the building of a test reactor for the use of Member States, establishment of a regional advisory committee on reactor safety, publication of an Agency journal reporting research work at the smaller centres, and establishment of a computer centre and exchange of computer codes.

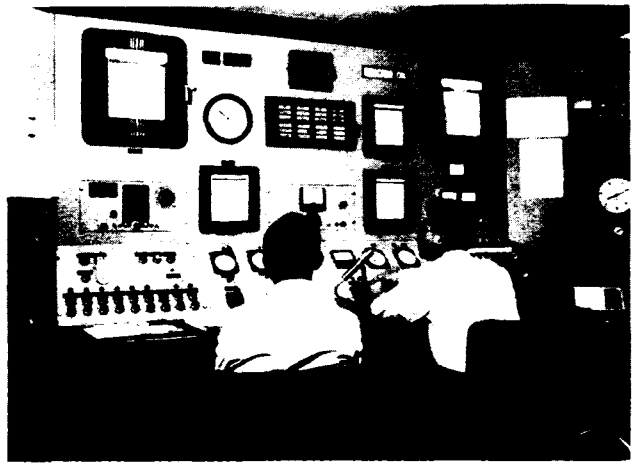
Regional Meetings

Like the Athens meeting, that at São Paulo provided an immediate benefit simply by bringing together the scientists. About 120 scientists took part, most of them from Latin American countries. Here again a strong desire was evident for the consolidation and development of these preliminary contacts by means of further meetings and joint projects. Many topics were proposed for joint projects, and the discussion suggested that those with the best chances of success would be in the field of chemistry.

In addition there was lengthy discussion of the possibility of improving co-operation not only between countries of the area, but also between different areas. The meeting indicated a preference for informal contacts between individual scientists rather than for more formal arrangements. Several countries in South America and two in Europe offered facilities for co-operation and for exchange of scientists. The need was stressed for IAEA to help in establishing such co-operative efforts.

At the Manila meeting there were over 50 participants from eleven countries including two from outside the region; five experts from outside the area attended. As the ground had already been prepared at Bangkok a year earlier, this meeting was able to concentrate on more specific technical matters, and did so at a high scientific level. Once again there was evident a strong desire for more closely-knit contacts and exchange of information. One concrete proposal was for the publication of a quarterly regional newsletter to describe the main activities at various research reactor centres, to indicate the

At the Instituto de Energia Atômica, Sao Paulo, Brazil. Control-room of the swimming-pool research reactor



possibilities of training and exchange of scientists and other matters of common interest. The Philippine Atomic Energy Commission offered to publish and distribute this newsletter for the first year.

Countries in the area were eager to participate in joint research and training programmes, and a number of offers of assistance were received.

An important suggestion was that an advisory group on reactor safety should be set up in the region. Such a group would have the advantages of familiarity with local conditions, greater continuity, and of being relatively inexpensive to assemble. On request, the group could make an objective evaluation of procedures for operation of the reactor and associated equipment; it could help with hazards evaluations of research reactors in existence or being planned, and could advise on procedures for qualifying reactor operators.

Another valuable step could be the establishment of a small advisory group on research reactor utilization in the Far East and South East Asia. Several countries in the area have had extensive experience with research reactors and could probably provide senior scientists who are familiar with local conditions. Such a group could help the new centres with the technical aspects of the programme, and could also be helpful in furthering regional collaboration.

There is evidently no lack of local talent and initiative in the regions where these meetings have been held. Given the lead, they should be able to organize a more fruitful utilization of research facilities, with the Agency supplementing local effort by acting as a clearing-house for information and assistance, on the lines indicated in its long-range plan.

The study group meetings are also helping to create greater awareness in the advanced countries about the work and needs of the developing centres. As a result, it may be hoped that the advanced centres will take greater interest in these new centres and establish closer relations with them. One method of achieving this could be through "sister laboratory" arrangements, whereby two centres join forces - at first in order to assist the newly-established one, but eventually for mutual benefit.

THE 1964 PROGRAMME OF HELP IN ATOMIC DEVELOPMENT

A wide variety of projects for the provision of experts and equipment to 32 countries has been approved by the IAEA Board of Governors for 1964. Further work is being financed under the United Nations Expanded Programme of Technical Assistance; altogether, the services of about 100 experts in the field are called for, in addition to those who are still at work on earlier assignments.

The estimated cost of the Agency's 1964 programme is $804 600, of which $459 200 is for the services of experts, and $345 400 for the provision of equipment and supplies. In addition, $513 500 is being allocated for EPTA programmes. It is becoming increasingly difficult, however, for the Agency to meet the growing number of requests and lack of finance may prevent its programme from being carried out in full. Many of these requests come from newly independent countries which have become Member States, and which seek assistance in developing national atomic energy programmes. In addition, numerous research reactors and radioisotope laboratories are being built or have recently been completed under bilateral arrangements which are normally limited to the period of construction. Most of these new centres then require some form of assistance in their programmes of research and training.

The programme outlined below forms a part only of the Agency's work in the field of technical assistance, which includes a number of other closely related activities, such as exchange of visiting professors, provision of fellowships, and organization of regional training courses - the latter often involving the provision of equipment. All these matters are now being administered by the Agency's Department of Technical Assistance.

The projects approved by the Board for this year cover a fairly wide range of topics - from raw materials prospecting and treatment to reactor construction, and from use of radioisotopes in fisheries research to their use in medicine. A number of common needs and interest are evident, however. Six of the countries require assistance in scientific documentation; they need some publications - princi-